

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2003-156333**
 (43)Date of publication of application : **30.05.2003**

(51)Int.Cl. **G01C 15/00**
G01C 3/06
G01S 17/08

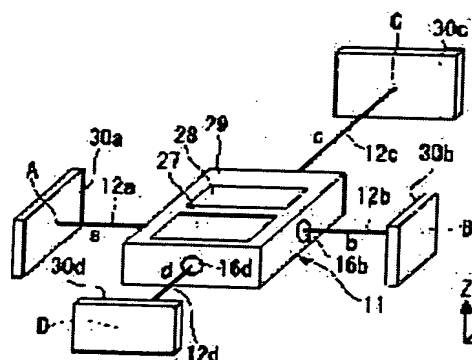
(21)Application number : **2001-355472** (71)Applicant : **NIKON CORP**
 (22)Date of filing : **21.11.2001** (72)Inventor : **AOKI SHIGERU**

(54) RANGING APPARATUS, INDOOR MEASURING APPARATUS USING THE SAME, AND TOTAL STATION

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a ranging apparatus that can simply obtain the position relation or the like among a plurality of objects to be measured, and at the same time, which does not necessarily require a tripod or the like.

SOLUTION: A transmission and reception optical system has a plurality of irradiation optical axes 12a to 12d, irradiates light along the irradiation optical axes 12a-12d, and receives each reflection light, corresponding to each irradiation light. A distance acquisition section obtains each of distances (a) to (d), to each of objects 30a to 30d to be measured existing on the extension of each of irradiation optical axes 12a to 12d, based on each reflected light received by the transmission and reception optical system.



The irradiation optical axes 12a to 12d are included in a specific reference plane or a plane nearly in parallel to the specific reference plane, and have an angle interval of nearly 90° each in the reference plane, when the irradiation optical axes 12a to 12d are mapped to the reference plane.

CLAIMS

- [Claim 1] Are transceiver optical system with two or more exposure opticals axis, and light is irradiated to timing different simultaneous, respectively in accordance with said two or more exposure opticals axis. To coincidence each reflected light corresponding to each exposure light irradiated respectively in accordance with said two or more exposure opticals axis, respectively Or the transceiver optical system received to different timing, The distance acquisition section which acquires each distance to each measuring object which exists on extension of said each exposure optical axis based on said each reflected light received according to said transceiver optical system, respectively, Two or more exposure opticals axis of a preparation and said two or more exposure opticals axis are distance measuring equipment characterized by fixing mutual relative physical relationship so that it may become mutually different sense.
- [Claim 2] Distance measuring equipment according to claim 1 characterized by having a means to search for the relative physical relationship between said each measuring object, based on each distance to said each measuring object obtained by said distance acquisition section.
- [Claim 3] A means to search for said relative physical relationship is distance measuring equipment according to claim 2 characterized by including a means to find the distance between said each measuring object.
- [Claim 4] A means to search for said relative physical relationship is distance measuring equipment according to claim 2 or 3 characterized by including a means to search for the relative coordinate of each of said measurement measuring object.
- [Claim 5] Distance measuring equipment according to claim 1 to 4 characterized by having a means to calculate the predetermined value about the configuration of two-dimensional [which was assumed beforehand, respectively, including respectively the location of each measuring object corresponding to said each exposure optical axis], or a three dimension based on each distance to said each measuring object obtained by said distance acquisition section.
- [Claim 6] Said two or more exposure opticals axis are distance measuring equipment according to claim 1 to 5 characterized by the mutual sense including two exposure opticals axis which make 90 degrees of abbreviation.
- [Claim 7] Said two or more exposure opticals axis are distance measuring equipment according to claim 1 to 5 characterized by the mutual sense including two exposure opticals axis which make 180 degrees of abbreviation.
- [Claim 8] said two or more exposure opticals axis -- the inside of a predetermined base plane or this predetermined base plane, and abbreviation -- the distance measuring equipment according to claim 1 to 5 characterized by having include-angle spacing of every 90 degrees of abbreviation in said base plane when the sense of said four exposure opticals axis maps said four exposure opticals axis in said base plane including four exposure opticals axis included in an parallel flat surface.

[Claim 9] The distance measuring equipment according to claim 8 characterized by to have a means find the die length equivalent to the die length of each side of the square in said base plane with the configuration which included four locations in said base plane which mapped the location of the four measuring objects corresponding to said four exposure opticals axis in said base plane, respectively on each side, respectively, and was assumed beforehand based on each distance to each of said measuring object obtained by said distance acquisition section.

[Claim 10] The distance measuring equipment according to claim 8 or 9 characterized by to have a means search for the relative coordinate of the location equivalent to each top-most vertices of the square in said base plane with the configuration which included four locations in said base plane which mapped the location of the four measuring objects corresponding to said four exposure opticals axis in said base plane, respectively on each side, respectively, and was assumed beforehand based on each distance to each of said measuring object obtained by said distance acquisition section.

[Claim 11] The area equivalent to the area of the square in said base plane with the configuration which included four locations in said base plane which mapped the location of the four measuring objects corresponding to said four exposure opticals axis in said base plane, respectively on each side, respectively, and was assumed beforehand Distance measuring equipment according to claim 8 to 10 characterized by having the means searched for based on each distance to said each measuring object obtained by said distance acquisition section.

[Claim 12] Distance measuring equipment according to claim 8 to 11 characterized by said configuration assumed beforehand being a rectangle.

[Claim 13] said two or more exposure opticals axis -- the inside of a predetermined base plane or this predetermined base plane, and abbreviation -- with four exposure opticals axis included in an parallel flat surface Two exposure opticals axis which make 90 degrees of abbreviation to said base plane, respectively while the mutual sense makes 180 degrees of abbreviation are included. The sense of said four exposure opticals axis Distance measuring equipment according to claim 1 to 5 characterized by having include-angle spacing of every 90 degrees of abbreviation in said base plane when said four exposure opticals axis are mapped in said base plane.

[Claim 14] Distance measuring equipment according to claim 13 characterized by having a means to find the die length equivalent to the die length of each side of hexahedron with the configuration which included the location of the six measuring objects corresponding to said four exposure opticals axis and said two exposure opticals axis on each field, respectively, and was assumed beforehand based on each distance to said each measuring object obtained by said distance acquisition section.

[Claim 15] Distance measuring equipment according to claim 13 or 14 characterized by having a means to search for the relative coordinate of the location equivalent to each top-most vertices of hexahedron with the configuration which included the location of the six measuring objects corresponding to said four exposure opticals axis and said two exposure opticals

axis on each field, respectively, and was assumed beforehand based on each distance to said each measuring object obtained by said distance acquisition section.

[Claim 16] Distance measuring equipment according to claim 13 to 15 characterized by having a means to ask for the area equivalent to the area of each side of hexahedron with the configuration which included the location of the six measuring objects corresponding to said four exposure opticals axis and said two exposure opticals axis on each field, respectively, and was assumed beforehand based on each distance to said each measuring object obtained by said distance acquisition section.

[Claim 17] Distance measuring equipment according to claim 13 to 16 characterized by having a means to ask for the volume equivalent to the volume of hexahedron with the configuration which included the location of the six measuring objects corresponding to said four exposure opticals axis and said two exposure opticals axis on each field, respectively, and was assumed beforehand based on each distance to said each measuring object obtained by said distance acquisition section.

[Claim 18] Distance measuring equipment according to claim 14 to 17 characterized by said configuration assumed beforehand being a rectangular parallelepiped.

[Claim 19] Said two or more exposure opticals axis include at least one exposure optical axis in addition to said two or more exposure opticals axis. The sense of said at least one exposure optical axis A detection means to be able to change relatively to the sense of said two or more exposure opticals axis, and to detect the relative sense of said at least one exposure optical axis over either of said two or more exposure opticals axis, Or distance measuring equipment according to claim 1 to 18 characterized by having an input means to input the data in which said relative sense is shown.

[Claim 20] The indoor metering device which is an indoor metering device which performs predetermined measurement about the interior of a room, and is characterized by having distance measuring equipment according to claim 1 to 19.

[Claim 21] Are transceiver optical system with two or more exposure opticals axis, and light is irradiated to timing different simultaneous, respectively in accordance with said two or more exposure opticals axis. To coincidence each reflected light corresponding to each exposure light irradiated respectively in accordance with said two or more exposure opticals axis, respectively Or the transceiver optical system received to different timing, The distance acquisition section which acquires each distance to each measuring object which exists on extension of said each exposure optical axis based on said each reflected light received according to said transceiver optical system, respectively, The sense of at least one exposure optical axis in a preparation and said two or more exposure opticals axis It can change relatively to the sense of other at least one exposure optical axis. said at least one exposure optical axis -- said -- others -- the distance measuring equipment characterized by having a detection means to detect the relative sense to at least one exposure optical axis, or an input means

to input the data in which said relative sense is shown.

[Claim 22] the total station equipped with distance measuring equipment according to claim 21 -- it is -- said -- others -- at least one exposure optical axis - facing down -- it is -- said -- others -- the total station characterized by obtaining the machine high of the total station concerned based on the distance acquired by said distance acquisition section in relation to at least one exposure optical axis.

[Claim 23] The total station according to claim 22 characterized by having had collimation optical system and said at least one exposure optical axis being in agreement with the optical axis of collimation optical system..

DETAILED DESCRIPTION

[0001]

[Field of the Invention] This invention relates to the indoor metering device and total station (measurement-of-angle range finder) which used this for distance measuring equipment and a list.

[0002]

[Description of the Prior Art] The total station which has from the former distance measuring equipment and this which are explained below in fields, such as a location survey, is used.

[0003] The transceiver optical system which receives the reflected light corresponding to the exposure light which this conventional distance measuring equipment had only the exposure optical axis of the (a) single, and light, such as infrared light, was irradiated in accordance with said exposure optical axis, and was irradiated in accordance with said exposure optical axis, (b) Based on the reflected light received according to said transceiver optical system, it has the distance acquisition section which acquires the distance to the measuring object which exists on extension of said exposure optical axis. Although various principles of ranging are known, the distance acquisition section finds the distance to the measuring object based on time difference with the time of luminescence of exposure light, and light-receiving of the reflected light from the measuring object, for example.

[0004] The conventional total station combines such conventional distance measuring equipment, and the level include angle of the circumference of the vertical axis of an exposure optical axis and the measurement-of-angle equipment which measures whenever [his statement angle-of-depression] (altitude include angle). At a total station, in order to usually use it, carrying in a tripod etc., it is necessary to get to know the height (machine high) of the co-ordinate basic origin from the ground. At the conventional total station, the machine high was measured by the operating personnel with the tape measure etc., and the data was inputted by input units, such as a control panel.

[0005]

[Problem(s) to be Solved by the Invention] However, at the conventional measuring device and the conventional conventional total station which were mentioned above, since it had only the single exposure optical axis, when searching for the physical relationship between two or more measuring objects etc. (for example, distance between two or more measuring objects), it is necessary to range by carrying out direction doubling of an exposure optical axis for two or more measuring objects of every one by one. For this reason, direction doubling of an exposure optical axis cannot take time amount and trouble, and physical relationship between two or more measuring objects etc. cannot be searched for easily. Moreover, an operating personnel must carry out the sequential input of each distance to each measuring object obtained by ranging

at the arithmetic units (microcomputer etc.) built in the equipment concerned, must make an arithmetic unit calculate the physical relationship between two or more measuring objects etc., and requires time amount and trouble also from this point. Furthermore, in order to perform direction doubling of an exposure optical axis, a revolution base, a tripod, etc. are required, and a cost rise is not escaped, either, while it enlarges as the whole equipment and weight increases.

[0006] The example of indoor measurement is given and explained about these points. For example, in relation to interiors, such as office and a residence, it may be requested that the dimension of indoor each part, a floor space, the area of a wall, the volume (volume) of a chamber, etc. should be measured. If these are measured, it can begin writing the drawing of a chamber, or can ask for the dimension of a required carpet, a curtain, etc., the number of sheets of a tile, etc., or selection of the furniture which can be arranged indoors, its layout, etc. can be determined, for example. For such indoor measurement, the example using the conventional measuring device and the conventional conventional total station which were mentioned above is explained with reference to drawing 17 and drawing 18.

[0007] Drawing 17 is the outline perspective view showing typically the situation of measurement by the conventional measuring device 111. This measuring device 111 is carried on the tripod 112 which has a revolution base. The transceiver optical system (not shown) built in the measuring device 111 has only one exposure optical axis 113. Drawing 18 is the outline perspective view showing typically the situation of measurement by the conventional total station 114. The body 115 of this total station 114 is carried on the tripod 116. The transceiver optical system built in this total station 114 has only one exposure optical axis 117. In drawing 17 and drawing 18, 118, 119 is a wall of the interior of a room as the measuring object which counters mutually, respectively, and distance measuring equipment 111 and the total station 114 are placed indoors, respectively.

[0008] As shown in drawing 17, when it is going to measure the distance between walls 118, 119 using distance measuring equipment 111, first, the equipment 111 concerned is placed indoors, the exposure optical axis 113 is turned to one wall 118, and the distance from the equipment 111 concerned to concerned one wall 118 is measured. This distance is displayed on a drop 120, and the operating personnel looks at and makes a note of this. Next, 180 degrees of sense of the equipment 111 concerned are changed, the exposure optical axis 113 is turned to the wall 119 of an opposite hand, and the distance from the equipment 111 concerned to the wall 9 of the opposite hand concerned is measured. This distance is displayed on a drop 120, and the operating personnel looks at and makes a note of this. Then, the distance to the wall 118, 119 whose note was made with the control panel 121 is inputted using the calculator function carried in the measuring device 111, and both distance is made to add. The addition result is the distance between the walls 118, 119 which counter, and is displayed on a drop 120. It is also the same as as shown in drawing 18, when it is going to measure the distance between walls 118, 119 using the total station 4.

[0009] Thus, when measuring the distance between walls 118,119 using conventional distance measuring equipment 111 and the conventional total station 114, one by one, it must range by carrying out direction doubling of the exposure optical axis 113,117 every wall 118,119 as the measuring object, the direction doubling cannot take time amount and trouble, and distance of a wall 118,119 cannot be found easily. Moreover, an operating personnel must carry out the sequential input of each distance to each wall 118,119 acquired by ranging at the arithmetic units (microcomputer etc.) built in the equipment concerned, must make an arithmetic unit calculate the distance between walls 118,119, and requires time amount and trouble also from this point. Furthermore, in order to perform direction doubling of the exposure optical axis 113,117, a revolution base and tripod 112,116 grade are required, and a cost rise is not escaped, either, while it enlarges as the whole equipment and weight increases.

[0010] Not only indoor measurement but in the others which measure the physical relationship between two or more measuring objects etc., such a situation is the same.

[0011] Moreover, at said conventional total station 114, since the machine high was measured by the operating personnel with the tape measure etc. and the data was inputted by input units, such as a control panel, as mentioned above, machine high measurement had taken trouble.

[0012] This invention was made in view of a situation which was mentioned above, and it aims at offering the distance measuring equipment which does not necessarily require a tripod etc., and the indoor metering device using this while it can search for easily the physical relationship between two or more measuring objects etc.

[0013] Moreover, this invention aims at offering the total station which machine high measurement does not take trouble.

[0014]

[Means for Solving the Problem] In order to solve said technical problem, the distance measuring equipment by the 1st mode of this invention Are transceiver optical system with two or more exposure opticals axis, and light is irradiated to timing different simultaneous, respectively in accordance with said two or more exposure opticals axis. To coincidence each reflected light corresponding to each exposure light irradiated respectively in accordance with said two or more exposure opticals axis, respectively Or the transceiver optical system received to different timing, The distance acquisition section which acquires each distance to each measuring object which exists on extension of said each exposure optical axis based on said each reflected light received according to said transceiver optical system, respectively, Mutual relative physical relationship is fixed so that two or more exposure opticals axis of a preparation and said two or more exposure opticals axis may serve as mutually different sense.

[0015] Said distance acquisition section finds the distance to the measuring object based on time difference with the time of luminescence of for example, exposure light, and light-receiving of the reflected light from the measuring object. But the ranging principle which can be adopted by this invention is not limited to what is depended on such time difference. This point is the same also

about each mode mentioned later.

[0016] The distance measuring equipment by the 2nd mode of this invention is equipped with a means to search for the relative physical relationship between said each measuring object, in said 1st mode based on each distance to said each measuring object obtained by said distance acquisition section.

[0017] A means by which the distance measuring equipment by the 3rd mode of this invention searches for said relative physical relationship in said 2nd mode includes a means to find the distance between said each measuring object.

[0018] A means by which the distance measuring equipment by the 4th mode of this invention searches for said relative physical relationship in said 2nd or 3rd mode includes a means to search for the relative coordinate of each of said measurement measuring object.

[0019] the 5th voice of this invention -- the distance measuring equipment twisted like -- said voice of either the 1st thru/or the 4th either -- it sets like and has a means to calculate the predetermined value about the configuration of two-dimensional [which was assumed beforehand, respectively, including respectively the location of each measuring object corresponding to said each exposure optical axis], or a three dimension based on each distance to said each measuring object obtained by said distance acquisition section.

[0020] the 6th voice of this invention -- the distance measuring equipment twisted like -- said voice of either the 1st thru/or the 5th either -- setting like, said two or more exposure opticals axis include two exposure opticals axis with which the mutual sense makes 90 degrees of abbreviation.

[0021] the 7th voice of this invention -- the distance measuring equipment twisted like -- said voice of either the 1st thru/or the 5th either -- setting like, said two or more exposure opticals axis include two exposure opticals axis with which the mutual sense makes 180 degrees of abbreviation.

[0022] The distance measuring equipment by the 8th mode of this invention is set in said mode of either the 1st thru/or the 5th either. Said two or more exposure opticals axis the inside of a predetermined base plane or this predetermined base plane, and abbreviation -- when the sense of said four exposure opticals axis maps said four exposure opticals axis in said base plane including four exposure opticals axis included in an parallel flat surface, it has include-angle spacing of every 90 degrees of abbreviation in said base plane.

[0023] The distance measuring equipment by the 9th mode of this invention is set in said 8th mode. The die length equivalent to the die length of each side of the square in said base plane with the configuration which included four locations in said base plane which mapped the location of the four measuring objects corresponding to said four exposure opticals axis in said base plane, respectively on each side, respectively, and was assumed beforehand It has the means searched for based on each distance to said each measuring object obtained by said distance acquisition section.

[0024] The distance measuring equipment by the 10th mode of this invention is set in said 8th or 9th mode. The relative coordinate of the location equivalent to each top-most vertices of the square in said base plane with the configuration which included four locations in said base plane which mapped the location of

the four measuring objects corresponding to said four exposure opticals axis in said base plane, respectively on each side, respectively, and was assumed beforehand It has the means searched for based on each distance to said each measuring object obtained by said distance acquisition section.

[0025] The distance measuring equipment by the 11th mode of this invention is set in said mode of either the 8th thru/or the 10th either. The area equivalent to the area of the square in said base plane with the configuration which included four locations in said base plane which mapped the location of the four measuring objects corresponding to said four exposure opticals axis in said base plane, respectively on each side, respectively, and was assumed beforehand It has the means searched for based on each distance to said each measuring object obtained by said distance acquisition section.

[0026] In said mode of either the 8th thru/or the 11th either, said configuration of the distance measuring equipment by the 12th mode of this invention assumed beforehand is a rectangle.

[0027] The distance measuring equipment by the 13th mode of this invention is set in said mode of either the 1st thru/or the 5th either. Said two or more exposure opticals axis the inside of a predetermined base plane or this predetermined base plane, and abbreviation -- with four exposure opticals axis included in an parallel flat surface When the sense of said four exposure opticals axis maps said four exposure opticals axis in said base plane including two exposure opticals axis which make 90 degrees of abbreviation to said base plane, respectively while the mutual sense makes 180 degrees of abbreviation, it has include-angle spacing of every 90 degrees of abbreviation in said base plane.

[0028] the 14th voice of this invention -- the distance measuring equipment which twists like -- said 13th voice -- it has a means find the die length equivalent to the die length of each side of hexahedron with the configuration which set like, and included the location of the six measuring objects corresponding to said four exposure opticals axis and said two exposure opticals axis on each field, respectively, and was assumed beforehand based on each distance to each of said measuring object obtained by said distance acquisition section.

[0029] The distance measuring equipment by the 15th mode of this invention is set in said 13th or 14th mode. The relative coordinate of the location equivalent to each top-most vertices of hexahedron with the configuration which included the location of the six measuring objects corresponding to said four exposure opticals axis and said two exposure opticals axis on each field, respectively, and was assumed beforehand It has the means searched for based on each distance to said each measuring object obtained by said distance acquisition section.

[0030] The distance measuring equipment by the 16th mode of this invention is set in said mode of either the 13th thru/or the 15th either. The area equivalent to the area of each side of hexahedron with the configuration which included the location of the six measuring objects corresponding to said four exposure opticals axis and said two exposure opticals axis on each field, respectively, and was assumed beforehand It has the means searched for based on each distance to said each measuring object obtained by said distance acquisition section.

[0031] The distance measuring equipment by the 17th mode of this invention is set in said mode of either the 13th thru/or the 16th either. The volume equivalent to the volume of hexahedron with the configuration which included the location of the six measuring objects corresponding to said four exposure opticals axis and said two exposure opticals axis on each field, respectively, and was assumed beforehand It has the means searched for based on each distance to said each measuring object obtained by said distance acquisition section.

[0032] In said mode of either the 14th thru/or the 17th either, said configuration of the distance measuring equipment by the 18th mode of this invention assumed beforehand is a rectangular parallelepiped.

[0033] The distance measuring equipment by the 19th mode of this invention is set in said mode of either the 1st thru/or the 18th either. Said two or more exposure opticals axis At least one exposure optical axis is included in addition to said two or more exposure opticals axis. The sense of said at least one exposure optical axis It can change relatively to the sense of said two or more exposure opticals axis, and has a detection means to detect the relative sense of said at least one exposure optical axis over either of said two or more exposure opticals axis, or an input means to input the data in which said relative sense is shown.

[0034] The indoor metering device by the 20th mode of this invention is an indoor metering device which performs predetermined measurement about the interior of a room, and is equipped with distance measuring equipment according to claim 1 to 19.

[0035] The distance measuring equipment by the 21st mode of this invention is transceiver optical system with two or more exposure opticals axis. In accordance with said two or more exposure opticals axis, light is irradiated to timing different simultaneous, respectively. To coincidence each reflected light corresponding to each exposure light irradiated respectively in accordance with said two or more exposure opticals axis, respectively Or the transceiver optical system received to different timing, The distance acquisition section which acquires each distance to each measuring object which exists on extension of said each exposure optical axis based on said each reflected light received according to said transceiver optical system, respectively, The sense of at least one exposure optical axis in a preparation and said two or more exposure opticals axis It can change relatively to the sense of other at least one exposure optical axis, and has a detection means to detect the relative sense to at least one exposure optical axis besides the above of said at least one exposure optical axis, or an input means to input the data in which said relative sense is shown.

[0036] the 22nd voice of this invention -- the total station depended like -- said 21st voice -- the total station equipped with the distance measuring equipment twisted like -- it is -- said -- others -- at least one exposure optical axis -- facing down -- it is -- said -- others -- based on the distance acquired by said distance acquisition section in relation to at least one exposure optical axis, it obtains the machine high of the total station concerned.

[0037] In said 22nd mode, the total station by the 23rd mode of this invention is equipped with collimation optical system, and said its at least one exposure optical axis corresponds with the optical axis of collimation optical system.

[0038]

[Embodiment of the Invention] Hereafter, the indoor metering device and total station which used this are explained to the distance measuring equipment by this invention, and a list with reference to a drawing.

[0039] [The gestalt of the 1st operation]

[0040] Drawing 1 is the outline perspective view showing typically the situation of measurement at the time of using the distance measuring equipment 11 by the gestalt of operation of the 1st of this invention as an indoor metering device.

Drawing 2 is the outline block diagram showing the distance measuring equipment 11 by the gestalt of this operation. Drawing 3 is an outline flowchart which shows an example of actuation of the distance measuring equipment 11 by the gestalt of this operation. Drawing 4 is an explanatory view for explaining the content of an operation by the distance measuring equipment 11 by the gestalt of this operation. In drawing 1 and drawing 4, the X-axis, the Y-axis, and the Z-axis which were defined on the basis of distance measuring equipment 11 and which intersect perpendicularly mutually are defined (the same is said of drawing mentioned later.). Moreover, the direction of +X and the sense of the objection are called the direction of -X for the sense of an arrow head among X shaft orientations. The same is said of Z shaft orientations and Y shaft orientations.

[0041] The distance measuring equipment 11 by the gestalt of this operation is equipped with transceiver optical system with four exposure opticals axis 12a-12d as shown in drawing 1 and drawing 2. This transceiver optical system is constituted from four individual separate shipment receiving optical system 13a-13d established corresponding to the exposure opticals axis 12a-12d, respectively by the gestalt of this operation.

[0042] With the gestalt of this operation, individual separate shipment receiving optical-system 13a has light emitting device 14a, such as infrared rays LED and laser, photo detector 15a, object optical-system 16a, and half mirror 17a. The exposure light which emitted light from light emitting device 14a penetrates half mirror 17a, and is irradiated along with exposure optical-axis 12a through object optical-system 16a. It is reflected by the measuring object (at the example shown in drawing 1, it is wall 30a) to which this exposure light exists on extension of exposure optical-axis 12a, and that reflected light is received by photo detector 15a after being reflected by half mirror 17a through return and object optical-system 16a along with exposure optical-axis 12a. The configuration of transceiver optical-system 13a is not limited to such a configuration, and an optical fiber etc. is suitably used if needed so that arrangement which exposure optical-axis 12a mentions later can be realized. Moreover, it consists of gestalten of this operation so that the light-receiving optical axis which receives the reflected light may be in agreement with exposure optical-axis 12a, but you may constitute so that a light-receiving optical axis may shift from an exposure optical axis.

[0043] The each separate shipment receiving optical system 13b-13c as well as individual separate shipment receiving optical-system 13a is constituted. Individual separate shipment receiving optical-system 13b has the elements 14b-17b corresponding to said elements 14a-17a. Individual separate shipment

receiving optical-system 13c has the elements 14c-17c corresponding to said elements 14a-17a, and 13d of individual separate shipment receiving optical system has the elements 14d-17d corresponding to said elements 14a-17a.

[0044] The distance measuring equipment 11 by the gestalt of this operation besides the transceiver optical system mentioned above With the processing according to each and the actuators 20a-20d which perform ranging data processing which acquires the distance to the measuring object based on light-receiving of the reflected light while performing luminescence actuation control to the each separate shipment receiving optical system 13a-13b, respectively Generalization control / processing section 26 which performs data processing which mentions the processing according to each, and Actuators 20a-20d later based on the distance acquired from the processing according to each, and Actuators 20a-20d while carrying out generalization control by answering a command from a control unit 27, It has the control unit 27 for an operating personnel to input various kinds of commands etc. and the displays 28, such as a liquid crystal display which displays a measurement result etc. Generalization control / processing section 26 is constituted using CPU etc. each component explained above -- the inside of a case 29 -- or it is prepared in the surface section of a case 29.

[0045] Individual processing and actuator 20a have the individual control and processing section 21a which consists of CPUs etc., timing measurement circuit 22a which consists of digital circuits etc., light emitting device actuation circuit 23a which drives light emitting device 14a and amplifying-circuit 24a which amplifies the light-receiving signal from photo detector 15a, and A/D-converter 25a which carries out A/D conversion of the amplified light-receiving signal. Individual control and processing section 21a answer a command from generalization control / processing section 26, and gives a ranging start signal to timing measurement circuit 22a. Timing measurement circuit 22a answers this ranging start signal, operates light emitting device actuation circuit 23a, makes light emitting device 14a emit light, and makes exposure light irradiate along with exposure optical-axis 12a. After the light-receiving signal (light-receiving signal of the reflected light which exposure light reflected by the measuring object) from photo detector 15a is amplified by amplifying-circuit 24a and A/D conversion is further carried out by A/D-converter 25a, it is inputted into timing measurement circuit 22a. Timing measurement circuit 22a measures time difference with the time of luminescence of exposure light, and light-receiving of the reflected light, and gives the time difference to individual control and processing section 21a. Individual control and processing section 21a find the distance a to the measuring object which exists on extension of exposure optical-axis 12a from the co-ordinate basic origin O of distance measuring equipment 11 by the operation based on the time difference acquired from timing measurement circuit 22a. This distance a is supplied to generalization control / processing section 26 from individual-processing actuator 20a.

[0046] Although not shown in a drawing, it is constituted like individual processing and actuator 20a which the processing according to each and Actuators 20b-20d also mentioned above.

[0047] Mutual relative physical relationship is being fixed so that the exposure opticals axis 12a-12d may serve as mutually different sense. With the gestalt of this operation, as shown in drawing 1 , it is contained in a predetermined base plane parallel to XY flat surface, the sense of the direction of +Y and 12d of exposure opticals axis is made [the sense of exposure optical-axis 12a / the sense of direction of -X and exposure optical-axis 12b] into the direction of -Y for the sense of direction of +X, and exposure optical-axis 12c, and the exposure opticals axis [12a-12d] sense has include-angle spacing of every 90 degrees in said base plane. Moreover, with the gestalt of this operation, exposure optical-axis 12a and exposure optical-axis 12b are on the same straight line, exposure optical-axis 12c and 12d of exposure opticals axis are on the same straight line, and the intersection of both straight lines is the co-ordinate basic origin O of distance measuring equipment 11.

[0048] With the gestalt of this operation, a case 29 is constituted in the shape of a rectangular parallelepiped, the top face and underside in drawing 1 of a case 29 are considered as XY flat surface and parallel, the left lateral and right lateral in drawing 1 of a case 29 are considered as YZ flat surface and parallel, and the side face of the near side in drawing 1 of a case 29 and the side face by the side of the back are considered as XZ flat surface and parallel. Therefore, the exposure opticals axis 12a-12d lie at right angles to the side face in which a case 29 corresponds, respectively.

[0049] Next, an example of actuation of the distance measuring equipment 11 by the gestalt of this operation is explained with reference to drawing 1 thru/or drawing 4 , especially drawing 3 .

[0050] For example, as shown in drawing 1 , distance measuring equipment 11 is placed indoors, and in performing indoor measurement using the distance measuring equipment 11 by the gestalt of this operation, it decides the sense of distance measuring equipment 11 so that the exposure opticals axis 12a-12d may become almost respectively vertical to the walls 30a-30d as each indoor measuring object. Since the exposure opticals axis 12a-12d lie at right angles to the side face in which a case 29 corresponds, respectively at this time as mentioned above, the sense of distance measuring equipment 11 can be easily set up by following these side faces as a rule of thumb, or making it a guide. For example, one side face of a case 29 may be forced on one wall. Although it is desirable that the exposure opticals axis 12a-12d are strictly vertical respectively to the indoor walls 30a-30d ideally, even if the sense shifts somewhat, there is no effect in the accuracy of measurement not much. Here, the chamber used as the object for measurement has the mutually parallel walls 30a and 30b which shall be rectangular parallelepipeds and counter mutually, and 30d is mutually parallel and makes Walls 30a and 30b and Walls 30c and 30d wall 30c which counters mutually, and the thing which lies at right angles. It is not necessary to necessarily carry distance measuring equipment 11 in a tripod etc. that what is necessary is just to only place, for example on a floor, a desk, etc. Of course, distance measuring equipment 11 may be carried in a tripod etc. if needed.

[0051] As shown in drawing 1 , the point on extension of the exposure opticals axis 12a-12d in Walls 30a-30d is set to A, B, C, and D, respectively. When the

relation of these points and co-ordinate basic origins O is mapped and seen from Z shaft orientations to said base plane, it is shown in drawing 4 .

[0052] If an operating personnel operates a control unit 27 and gives the initiation command of measurement after it arranges distance measuring equipment 11 in this way, generalization control / processing section 26 will answer this command, and will give a ranging initiation command to the processing according to each, and Actuators 20a-20d, respectively. The processing according to each and Actuators 20a-20d perform actuation which answered these ranging initiation commands and was mentioned above, and supply each distance a-d from the co-ordinate basic origin O to each walls [30a-30d] each point A, B, C, and D to generalization control / processing section 26, respectively (step S1 in drawing 3). in addition, generalization control / processing section 26 -- individual processing and an actuator 20 -- you may control to operate a-20d

simultaneously, and may make it make it operate one by one in time sharing [0053] Next, generalization control / processing section 26 will compute the dimensions L1 and L2 of each side of the rectangle GHJK in drawing 4 based on each distance a-d, if each distance a-d is obtained from individual processing and Actuators 20a-20d (step S2 in drawing 3). A rectangle GHJK is a square which has the shape of a rectangle (two-dimensional configuration) as a configuration which included the point (these mapping points are Points A, B, and C and the D itself with the gestalt of this operation.) which mapped Points A, B, C, and D in said base plane on each side, respectively, and was assumed beforehand. The dimensions L1 and L2 of each side computable [the following several 1 and several 2] are clear.

[0054]

[Equation 1] $L1=a+b$ [0055]

[Equation 2] $L2=c+d$ [0056] Subsequently, generalization control / processing section 26 computes the relative coordinate of the top-most vertices G, H, J, and K of a rectangle GHJK based on each distance a-d (step S3 in drawing 3). The relative coordinate by XY coordinate (the relative coordinate of other formats is sufficient.) of these top-most vertices is computable as $G=(-a, c)$, $H=(b, c)$, $J=(b, -d)$, and $K=(-a, -d)$. It cannot be overemphasized that the zero of these relative coordinates may be changed suitably.

[0057] Then, generalization control / processing section 26 computes the area P of a rectangle GHJK by the following several 3 based on each distance a-d (step S4 of drawing 3).

[0058]

[Equation 3] $P=(a+b) \times (c+d)$

[0059] Finally, generalization control / processing section 26 displays on a display 28 the area P computed by the relative coordinate of each top-most vertices G, H, J, and K computed at each distance a-d measured at step S1, the dimensions L1 and L2 computed at step S2, and step S3, and step S4 (step S5 of drawing 3), and ends a series of actuation.

[0060] In the example of measurement explained above, dimensions L1 and L2 are the length of the floor (head lining) of a chamber, and a horizontal dimension, the relative coordinate of each top-most vertices G, H, J, and K is a relative

coordinate of each top-most vertices in the top view of a chamber, and area P is a floor space (head-lining area). According to the gestalt of this operation, these values can be measured only by doubling only once, as the sense of distance measuring equipment 11 was mentioned above, therefore the measurement is very easy. And it is as having mentioned above that it is not necessary to necessarily use a tripod etc.

[0061] In addition, if the sense of distance measuring equipment 11 is set up so that exposure optical-axis a-d may become respectively vertical to the wall of one wall of head lining and one pair of walls which counter mutually, a floor, and another side of said one pair of walls for example, it can ask for the relative coordinate and area of the dimension and each top-most vertices of one pair of remaining walls.

[0062] Although the exposure opticals axis 12a-12d were included in the predetermined base plane parallel to XY flat surface and the co-ordinate basic origin O was with the gestalt of operation mentioned above on extension of each exposure opticals axis 12a-12d, this invention is not limited to this. For example, exposure optical-axis 12a may shift in the direction of arbitration from the co-ordinate basic origin O, making the sense into the direction of -X, and is the same about other exposure opticals axis 12b-12d.

[0063] Moreover, for example, as the sense of exposure optical-axis 12c is shown in drawing 5, only the include angle theta 1 may lean to the direction of +Y in the flat surface parallel to XY flat surface. In this case, although the distance acquired from individual processing and actuator 20c is distance c' in drawing 5, since the relation between c' and $\cos\theta_1=c$ is materialized, it can ask for each dimension mentioned above like the gestalt of operation mentioned above by using this relation. In addition, drawing 5 is an explanatory view corresponding to drawing 4. In drawing 5, point C' is a point on extension of exposure optical-axis 12c in wall 30c at the time of leaning, as the sense of exposure optical-axis 12c was mentioned above. Distance c' is the distance from a co-ordinate basic origin O to point C'.

[0064] Similarly, as the sense of exposure optical-axis 12c is shown in drawing 6, only the include angle theta 2 may lean to the direction of +Y in the flat surface parallel to YZ flat surface. In this case, although the distance acquired from individual processing and actuator 20c is distance c" in drawing 6, since the relation between c" and $\cos\theta_2=c$ is materialized, it can ask for each dimension mentioned above like the gestalt of operation mentioned above by using this relation. In addition, although drawing 6 is an explanatory view corresponding to drawing 4, it is seen from X shaft orientations. In drawing 6, point C" is a point on extension of exposure optical-axis 12c in wall 30c at the time of leaning, as the sense of exposure optical-axis 12c was mentioned above. Distance c" is the distance from a co-ordinate basic origin O to point C."

[0065] Since the sense of exposure optical-axis 12c may be leaned as shown in drawing 5, and it may be leaned as shown in drawing 6, it turns out after all that you may lean in the direction of arbitration to the direction of +Y. This is the same about other exposure opticals axis 12a, 12b, and 12d. After all, mutual relative physical relationship should just be fixed so that the exposure opticals axis 12a-

12d may serve as mutually different sense. However, if the exposure opticals axis 12a-12d do not shine upon the walls 30a-30d on all sides, respectively, a dimension which was mentioned above cannot be obtained. therefore -- if it takes into consideration that the dimension of a chamber is of infinite variety -- the exposure opticals axis 12a-12d -- the inside of a predetermined base plane or this predetermined base plane, and abbreviation -- when it is contained in an parallel flat surface and the exposure opticals axis 12a-12d are mapped in said base plane, it is desirable to have include-angle spacing of every 90 degrees of abbreviation in said base plane.

[0066] By the way, with the gestalt of operation mentioned above, as explained in relation to step S2 in drawing 3 - S4, it is asking for the relative coordinate and area of the dimension about the square GHJK in drawing 4 , and top-most vertices, using the shape of a rectangle as a configuration assumed beforehand. However, the configuration assumed by step S2 - S4 is not necessarily limited to a rectangle, and may assume a trapezoid configuration as shown in drawing 7 . As information (configuration information except magnitude) which specifies this trapezoid configuration, three include angles can be mentioned, for example. In this case, it is clear from geometric relation that the dimension of each side with the trapezoid configuration concerned which includes Points A, B, C, and D on each side of trapezoid G'H'JK, the relative coordinate of each top-most vertices, and area are computable from ranging value a-d. There is also a chamber which has such a trapezoid configuration plentifully. Since there are many chambers with the shape of a rectangle overwhelmingly actually, an operating personnel enables it to set the configuration which should be assumed by step S2 - S4 also to configurations other than the shape of a rectangle, and generalization control / processing section 26 should just calculate step S2 - S4 according to the set-up configuration. What is necessary is for setting out of such an operating personnel of a configuration to be able to build the user interface which can choose an operating personnel from among the various configurations assumed beforehand, or for an operating personnel just to enable it to input the information which specifies the configuration which should be assumed. What is necessary is for the operating personnel just to enable it to input three include angles of the chamber beforehand measured with a certain means, if it is the case of the latter, for example, a trapezoid configuration as shown in drawing 7 . In addition, drawing 7 is an explanatory view corresponding to drawing 4 .

[0067] Although the above explained the configuration to assume about the square-like case, there may not be that to which the configuration to assume is not necessarily limited in the shape of a square, and may be the two-dimensional configuration of other arbitration.

[0068] Although the case where the distance measuring equipment 11 by the gestalt of this operation was used as an indoor metering device was mentioned as the example and the above explanation explained it, it cannot be overemphasized that the application of the distance measuring equipment 11 by the gestalt of this operation is not limited to indoor measurement.

[0069] [The gestalt of the 2nd operation]

[0070] Drawing 8 is the outline block diagram showing the distance measuring

equipment 40 by the gestalt of operation of the 2nd of this invention. In drawing 8, the same sign is given to the same as that of the element in drawing 1 and drawing 2, or a corresponding element, and the overlapping explanation is omitted.

[0071] The place where the distance measuring equipment 40 by the gestalt of this operation differs from the distance measuring equipment 11 by the gestalt of said 1st operation As opposed to the individual separate shipment receiving optical system 13a-13d, and individual processing and actuators 20a-20d mainly being formed with the gestalt of said 1st operation corresponding to each exposure optical axis 12a-12d, respectively It is the point of having attained communalization to each exposure optical axis 12a-12d about transceiver optical system, and processing and an actuator, by adopting the optical switches 41a-41d of the mechanical cable type which uses a motor etc. as an actuator with the gestalt of this operation. In addition, also in the gestalt of this operation, each exposure optical axis [12a-12d] relative physical relationship is the same as the gestalt of said 1st operation.

[0072] The transceiver optical system with four exposure optical axis 12a-12d is constituted from every one light emitting device 14 and a photo detector 15, said optical switches 41a-41d, the object optical system 16a-16d, and half mirrors 17, 42a-42d by the gestalt of this operation, respectively. After the exposure light emitted from the light emitting device 14 penetrates a half mirror 17, with half mirrors 42a-42b, it branches to four optical paths and is irradiated in accordance with each exposure optical axis 12a-12d through the object optical system 16a-16d, respectively. After passing through the same optical path as exposure light, it is reflected by the half mirror 17, and the reflected light from each measuring object which exists on extension of each exposure optical axis 12a-12d is received by the photo detector 15. Optical switches 41a-41d are arranged at said four branched optical paths, respectively, and can open and close a corresponding optical path now.

[0073] The timing measurement circuit 22 which performs the respectively same actuation as the elements 22a-25a in drawing 2 besides [which mentioned above the distance measuring equipment 40 by the gestalt of this operation] transceiver optical system, the light emitting device actuation circuit 23, an amplifying circuit 24, and A/D converter 25, It has control / processing section 20 also having the function equivalent to the individual control and processing section 21a in drawing 2, and generalization control / processing section 26, and the optical switch actuation circuit 43 which drives optical switches 41a-41d. Control / processing section 20 is constituted using CPU etc. In addition, the distance measuring equipment 40 by the gestalt of this operation is also the same with the gestalt of the 1st operation, and it has the control unit 27 and the display 28.

[0074] Control / processing section 20 answers the initiation command of the measurement from a control unit 27, first, controls the optical switch actuation circuit 43, and changes only optical switch 41a into the condition of having closed the optical switches 41b-41d besides an aperture selectively. A ranging initiation command is given to the timing measurement circuit 22 in this condition.

Consequently, exposure light is irradiated only from exposure optical-axis 12a, only the reflected light corresponding to this is received by the photo detector 15, time difference with the time of luminescence of the exposure light which met exposure optical-axis 12a by the timing measurement circuit 22, and light-receiving of the reflected light is measured, and the time difference is given to control / processing section 20. Control / processing section 20 finds the distance a to the measuring object which exists on extension of exposure optical-axis 12a from the co-ordinate basic origin O of distance measuring equipment 40 by the operation based on this time difference.

[0075] Next, control / processing section 20 finds the distance b, c, and d to each measuring object which exists every one [optical switches / 41b 41c, and 41d] in a sequential selection target on extension of the co-ordinate basic origin O of distance measuring equipment 40 to an aperture and the exposure optical axis 12b, 12c, and 12d one by one.

[0076] If all distance a-d is obtained, control / processing section 20 will perform the same processing as processing of steps S2-S5 in drawing 3 , and will end processing.

[0077] According to the gestalt of this operation, the same advantage as the gestalt of said 1st operation is acquired, and also compared with the gestalt of the 1st operation, components mark are reduced and a miniaturization and cost cut of equipment can be aimed at. In addition, if the optical switch which replaces the mechanical-cable-type optical switches 41a-41d is carried on this waveguide device using the waveguide device which carried a part of transceiver optical system [at least], a miniaturization and cost cut of equipment can be aimed at further.

[0078] [The gestalt of the 3rd operation]

[0079] Drawing 9 is the outline perspective view showing typically the situation of measurement at the time of using the distance measuring equipment 50 by the gestalt of operation of the 3rd of this invention as an indoor metering device. In drawing 9 , the same sign is given to the same as that of the element in drawing 1 , or a corresponding element, and the overlapping explanation is omitted.

[0080] The place where the distance measuring equipment 50 by the gestalt of this operation differs from the distance measuring equipment 11 by the gestalt of said 1st operation is only the point that the individual separate shipment receiving optical system 13c and 13d, and individual processing and actuators 20c and 20d of drawing 2 are removed, and actuation of generalization control / processing section 26 is changed in connection with this.

[0081] With the gestalt of this operation, if each distance a and b is acquired from individual processing and Actuators 20a and 20b, generalization control / processing section 26 will compute the distance between Points A and B ($=a+b$), will compute the relative coordinate of Points A and B, will display these on a display 28, and will end processing.

[0082] According to the gestalt of this operation, by one measurement actuation, only the distance between 1 pair of wall 30a which counters, and 30b can be measured, but compared with the case where the distance between wall 30a and 30b is measured using conventional distance measuring equipment and the

conventional conventional total station, the distance concerned can be measured easily.

[0083] Like the gestalt of this operation, even if it is the case where distance measuring equipment 50 has only two exposure opticals axis 12a and 12b If it changes into the condition of having changed 90-degree sense into the circumference of the Z-axis from the arrangement which shows distance measuring equipment 50 to drawing 9 and same measurement is performed once again Each distance c and d to the walls 30c and 30d in drawing 1 can also be acquired, as a result said dimensions L1 and L2, the relative coordinate of each top-most vertices G, H, J, and K, and area P can be obtained like the case of the gestalt of said 1st operation. In this case, generalization control / processing section 26 receives the command of the purport which is the command of a purport and the 2nd measurement which are such the 1st measurement from a control unit 27, and answers each command. After storing each distance a and b and each distance c and d in memory, respectively and acquiring each distance c and d by the 2nd measurement, said dimensions L1 and L2, the relative coordinate of each top-most vertices G, H, J, and K, and area P may be computed, and you may make it display on a display 28 automatically based on each distance a-d.

[0084] In addition, it cannot be overemphasized that the application of the distance measuring equipment 50 by the gestalt of this operation is not limited to indoor measurement, either.

[0085] [The gestalt of the 4th operation]

[0086] Drawing 10 is the outline perspective view showing typically the situation of measurement at the time of using the distance measuring equipment 60 by the gestalt of operation of the 4th of this invention as an indoor metering device. In drawing 10, the same sign is given to the same as that of the element in drawing 1, or a corresponding element, and the overlapping explanation is omitted.

[0087] The place where the distance measuring equipment 60 by the gestalt of this operation differs from the distance measuring equipment 11 by the gestalt of said 1st operation is only the point that the individual separate shipment receiving optical system 13b and 13d, and individual processing and actuators 20b and 20d are removed, and actuation of generalization control / processing section 26 is changed in connection with this.

[0088] With the gestalt of this operation, if each distance a and c is acquired from individual processing and Actuators 20a and 20c, generalization control / processing section 26 will compute the distance between Points A and C ($= (a^2+c^2)^{1/2}$), will compute the relative coordinate of Points A and C, will display these on a display 28, and will end processing.

[0089] According to the gestalt of this operation, by one measurement actuation, only the distance between one pair of points A of wall 30a and the points C of wall 30c which counter can be measured, but compared with the case where the distance between Points A and C is measured using conventional distance measuring equipment and the conventional conventional total station, the distance concerned can be measured easily.

[0090] Like the gestalt of this operation, even if it is the case where distance

measuring equipment 60 has only two exposure opticals axis 12a and 12c If it changes into the condition of having changed 180-degree sense into the circumference of the Z-axis from the arrangement which shows distance measuring equipment 60 to drawing 10 and same measurement is performed once again Each distance b and d to the walls 30b and 30d in drawing 1 can also be acquired, as a result said dimensions L1 and L2, the relative coordinate of each top-most vertices G, H, J, and K, and area P can be obtained like the case of the gestalt of said 1st operation. In this case, generalization control / processing section 26 receives the command of the purport which is the command of a purport and the 2nd measurement which are such the 1st measurement from a control unit 27, and answers each command. After storing each distance a and c and each distance b and d in memory, respectively and acquiring each distance b and d by the 2nd measurement, said dimensions L1 and L2, the relative coordinate of each top-most vertices G, H, J, and K, and area P may be computed, and you may make it display on a display 28 automatically based on each distance a-d.

[0091] In addition, it cannot be overemphasized that the application of the distance measuring equipment 60 by the gestalt of this operation is not limited to indoor measurement, either.

[0092] [The gestalt of the 5th operation]

[0093] Drawing 11 is the outline perspective view showing typically the situation of measurement at the time of using the distance measuring equipment 70 by the gestalt of operation of the 5th of this invention as an indoor metering device. In drawing 11, the same sign is given to the same as that of the element in drawing 1, or a corresponding element, and the overlapping explanation is omitted.

Moreover, drawing 12 is an explanatory view for explaining the content of an operation by the distance measuring equipment 70 by the gestalt of this operation. Drawing 13 is an outline flowchart which shows an example of actuation of the distance measuring equipment 70 by the gestalt of this operation.

[0094] Since the configuration of the distance measuring equipment 70 by the gestalt of this operation is the same as that of the configuration and basic target of distance measuring equipment 11 by the gestalt of said 1st operation, refer to it also for drawing 2 besides drawing 11 thru/or drawing 13 on the occasion of explanation of the gestalt of this operation.

[0095] The place where the distance measuring equipment 70 by the gestalt of this operation differs from the distance measuring equipment 11 by the gestalt of said 1st operation (i) The point that transceiver optical system has two exposure opticals axis 12e and 12f in the others which are four exposure opticals axis 12a-12d as shown in drawing 11, (ii) Transceiver optical system to individual separate shipment receiving optical system [13a-13d] others The point of having two individual separate shipment receiving optical system 13e and 13f (not shown) which has the same configuration as individual separate shipment receiving optical-system 13a respectively corresponding to the exposure opticals axis 12e and 12f, (iii) They are the point that two individual processing and the actuators 20e and 20f (not shown) which have the same configuration as

individual processing and actuator 20a respectively corresponding to the exposure opticals axis 12e and 12f are added, and the point that actuation of (iv) generalization control / processing section 26 is changed.

[0096] With the gestalt of this operation, as for the exposure opticals axis 12e and 12f, the relative physical relationship over the exposure opticals axis 12a-12d is being fixed so that the sense whose sense of exposure optical-axis 12e is + Z direction and 12f of exposure opticals axis may serve as - Z direction. With the gestalt of this operation, the exposure opticals axis 12e and 12f are on the same straight line which passes along the co-ordinate basic origin O of distance measuring equipment 70.

[0097] Next, an example of actuation of the distance measuring equipment 70 by the gestalt of this operation is explained with reference to drawing 13.

[0098] For example, as shown in drawing 11, distance measuring equipment 70 is placed indoors, and in performing indoor measurement using the distance measuring equipment 70 by the gestalt of this operation, it decides the sense of distance measuring equipment 70 so that the exposure opticals axis 12a-12f may become almost respectively vertical to the walls 30a-30d as each indoor measuring object, head-lining 30e, and 30f of floors. Since the exposure opticals axis 12a-12f lie at right angles to the side face in which a case 29 corresponds, a top face, and a base, with the gestalt of this operation, respectively at this time, the sense of distance measuring equipment 70 can be easily set up by following these side faces, a top face, and a base as a rule of thumb, or making it a guide. For example, one side face of a case 29 may be forced on one wall. Although it is desirable that the exposure opticals axis 12a-12f are strictly vertical respectively to the indoor walls 30a-30d, head-lining 30e, and 30f of floors ideally, even if the sense shifts somewhat, there is no effect in the accuracy of measurement not much. It considers as wall which wallsa [30] and 30b which chamber which serves as object for measurement here shall be rectangular parallelepiped, and counter mutually are mutually parallel, and counters mutually 30c, and the thing to which it is mutually [30d] parallel, and is mutually [head-lining 30e and 30f of floors] parallel, and head-lining 30e and 30f of floors lie at right angles, respectively in Walls 30a and 30b and Walls 30c and 30d. It is not necessary to necessarily carry distance measuring equipment 70 in a tripod etc. that what is necessary is just to only place, for example on a floor etc. Of course, distance measuring equipment 70 may be carried in a tripod etc. if needed.

[0099] As shown in drawing 11, the point on extension of the exposure opticals axis 12a-12f in Walls 30a-30d, head-lining 30e, and 30f of floors is set to A, B, C, D, E, and F, respectively. The relation of these points and co-ordinate basic origins O is shown in drawing 12.

[0100] If an operating personnel operates a control unit 27 and gives the initiation command of measurement after it arranges distance measuring equipment 70 in this way, generalization control / processing section 26 will answer this command, and will give a ranging initiation command to the processing according to each, and Actuators 20a-20f, respectively. Actuation which answered the processing according to each and Actuators 20a-20f, and these ranging initiation commands, and was mentioned above is performed, and each distance a-f from

the co-ordinate basic origin O to each point A, B, C, D, E, and F of each walls 30a-30d, head-lining 30e, and 30f of floors is supplied to generalization control / processing section 26, respectively (step S11 in drawing 13). in addition, generalization control / processing section 26 -- individual processing and an actuator 20 -- you may control to operate a-20f simultaneously, and may make it make it operate one by one in time sharing

[0101] Next, generalization control / processing section 26 will compute the dimensions L1, L2, and L3 of each side of the rectangular parallelepiped MNQRSTUW in drawing 12 based on each distance a-f, if each distance a-f is obtained from individual processing and Actuators 20a-20f (step S12 in drawing 13). A rectangular parallelepiped MNQRSTUW is hexahedron which has a rectangular parallelepiped configuration (three-dimension configuration) as a configuration which included Points A, B, C, D, E, and F on each side, and was assumed beforehand. The dimensions L1, L2, and L3 of each side computable [with the following several 4 - a-six number] are clear.

[0102]

[Equation 4] $L1=a+b$ [0103]

[Equation 5] $L2=c+d$ [0104]

[Equation 6] $L3=e+f$ [0105] Subsequently, generalization control / processing section 26 computes the relative coordinate of the top-most vertices M, N, Q, R, S, T, U, and W of a rectangular parallelepiped MNQRSTUW based on each distance a-f (step S13 in drawing 13). The relative coordinate by the XYZ coordinate (the relative coordinate of other formats is sufficient.) of these top-most vertices As $M=(-a, c, e)$, $N=(b, c, e)$, $Q=(-b, d, e)$, $R=(-a, -d, e)$, $S=(-a, c, -f)$, $T=(b, c, -f)$, $U=(b, -d, -f)$, and $W=(-a, -d, -f)$ It is computable. It cannot be overemphasized that the zero of these relative coordinates may be changed suitably.

[0106] Then, generalization control / processing section 26 computes the area P3 of a rectangle MNTS and a rectangle RQUW with several 7 - a-nine number based on each distance a-f in the area P2 of the area P1 of a rectangle MNQR and a rectangle STUW, a rectangle RMSW, and a rectangle QNTU, and a list (step S14 of drawing 13).

[0107]

[Equation 7] $P1=(a+b) \times (c+d)$

[0108]

[Equation 8] $P2=(c+d) \times (e+f)$

[0109]

[Equation 9] $P3=(a+b) \times (e+f)$

[0110] Next, generalization control / processing section 26 computes the volume V of a rectangular parallelepiped MNQRSTUW by the following several 10 based on each distance a-f (step S15 of drawing 13).

[0111]

[Equation 10] $V=(a+b) \times (c+d) \times (e+f)$

[0112] Each distance a-f by which generalization control / processing section 26 was finally measured at step S11, The relative coordinate of each top-most vertices M, N, Q, R, S, T, U, and W computed at the dimensions L1, L2, and L3

computed at step S12, and step S13, The area P1, P2, and P3 computed at step S14 and the volume V computed at step S15 are displayed on a display 28 (step S16 of drawing 13), and a series of actuation is ended.

[0113] In the example of measurement explained above, dimensions L1, L2, and L3 are dimensions of the length of the floor (head lining) of a chamber, width, and head-lining height, the relative coordinate of each top-most vertices M, N, Q, R, S, T, U, and W is a relative coordinate of each corner of a chamber, area P1 is a floor space (head-lining area), area P2 and P3 is wall surface products, respectively, and the volume V is volume of a chamber. According to the gestalt of this operation, these values can be measured only by doubling only once, as the sense of distance measuring equipment 70 was mentioned above, therefore the measurement is very easy. And it is as having mentioned above that it is not necessary to necessarily use a tripod etc.

[0114] With the gestalt of operation mentioned above, although the co-ordinate basic origin O was on extension of each exposure opticals axis 12a-12d, this invention is not limited to this. For example, exposure optical-axis 12a may shift in the direction of arbitration from the co-ordinate basic origin O, making the sense into the direction of -X, and is the same about other exposure opticals axis 12b-12f.

[0115] Moreover, the sense of exposure optical-axis 12c may be leaned in the direction of arbitration to the direction of +Y like the case of the gestalt of said 1st operation. This is the same about other exposure opticals axis 12a, 12b, 12d-12f. However, if the exposure opticals axis 12a-12f do not hit Walls 30a-30d, head-lining 30e, and 30f of floors, respectively, a dimension which was mentioned above cannot be obtained. When a thing of infinite variety is taken into consideration, the dimension of a chamber therefore, the exposure opticals axis 12a-12f the inside of a predetermined base plane or this predetermined base plane, and abbreviation, when it is contained in an parallel flat surface and the exposure opticals axis 12a-12d are mapped in said base plane It has include-angle spacing of every 90 degrees of abbreviation in said base plane, and as for the exposure opticals axis 12e and 12f, it is desirable to make 90 degrees of abbreviation to said base plane, respectively while the mutual sense makes 180 degrees of abbreviation.

[0116] By the way, with the gestalt of operation mentioned above, as explained in relation to steps S12-S15 in drawing 3 , it is asking for the dimension about the rectangular parallelepiped MNQRSTUW in drawing 12 , the relative coordinate of top-most vertices, area, and the volume, using a rectangular parallelepiped configuration as a configuration assumed beforehand. However, the configuration assumed at steps S12-S15 may not necessarily be limited to a rectangular parallelepiped, and may be a three-dimension configuration of other arbitration other than hexahedron. The configuration assumed by step S2 - S4 in the gestalt of said 1st operation is not limited to a rectangle, but that of this point is the same as that of the thing which may be the two-dimensional configuration of arbitration.

[0117] Although the case where the distance measuring equipment 70 by the gestalt of this operation was used as an indoor metering device was mentioned

as the example and the above explanation explained it, it cannot be overemphasized that the application of the distance measuring equipment 70 by the gestalt of this operation is not limited to indoor measurement.

[0118] [The gestalt of the 6th operation]

[0119] Drawing 14 is the outline perspective view showing typically the situation of measurement of the distance measuring equipment 80 by the gestalt of operation of the 6th of this invention. In drawing 14, the same sign is given to the same as that of the element in drawing 9, or a corresponding element, and the overlapping explanation is omitted.

[0120] The place where the distance measuring equipment 80 by the gestalt of this operation differs from the distance measuring equipment 50 by the gestalt of the 3rd operation shown in drawing 9 As opposed to the mutual relative physical relationship of the exposure opticals axis 12a and 12b being fixed with the gestalt of said 3rd operation with the gestalt of this operation The point which is constituted so that exposure optical-axis 12a may be relatively rotated to the circumference of a shaft parallel to the Z-axis to exposure optical-axis 12b, changes the sense of exposure optical-axis 12a relatively to the sense of exposure optical-axis 12b, and can be set up now, It is a point equipped with include-angle detectors (not shown), such as a rotary encoder for detecting the sense of exposure optical-axis 12a. Moreover, with the gestalt of this operation, generalization control / processing section 26 computes the distance between both the measuring objects not only based on the distance to the measuring object in alignment with exposure optical-axis 12a, and the distance to the measuring object in alignment with exposure optical-axis 12b but based on the include angle which shows the sense of exposure optical-axis 12a.

[0121] Instead of forming the include-angle detector which detects the sense of exposure optical-axis 12a, the angle index which shows the sense of exposure optical-axis 12a is attached, the include angle which an operating personnel reads the graduation and shows the sense of exposure optical-axis 12a is inputted by the control unit 27, and you may make it generalization control / processing section 26 use the inputted sense.

[0122] Since according to the gestalt of this operation the same advantage as the gestalt of said 3rd operation is acquired and also the sense of exposure optical-axis 12a can be changed, compared with the gestalt of said 3rd operation, the high measurement of a degree of freedom of the ability to measure the distance for two points in the angular position of arbitration is attained.

[0123] In addition, you may apply to the gestalt of the 5th operation which shows the deformation same with having transformed the gestalt of said 3rd operation and having acquired the gestalt of this operation to drawing 1 and which is shown in the gestalt and drawing 11 of the 1st operation.

[0124] [The gestalt of the 7th operation]

[0125] Drawing 15 is the outline perspective view showing typically the total station 90 by the gestalt of operation of the 7th of this invention. Drawing 16 is the outline sectional view showing typically the cross section which met the 100-100' line in drawing 15.

[0126] The total station 90 by the gestalt of this operation is equipped with the

tripod 91 and the body 92 carried on the tripod 91. It has the body 92 with a head 93, the supporters 94a and 94b which support a head 93 pivotable to the circumference of a horizontal axis, and the base 95 which supports Supporters 94a and 94b pivotable to the circumference of a vertical axis.

[0127] On a body 92, collimation optical system, the individual separate shipment receiving optical system 13a and 13b in drawing 2, individual processing and actuators 20a and 20b, generalization control / processing section 26, a control unit 27, and a display 28, Angle gauges for altitude include angles, such as an encoder which measures angle of rotation (altitude include angle) of the circumference of the horizontal axis over the supporters 94a and 94b of a head 93 (not shown), Angle gauges for level include angles (not shown), such as an encoder which measures angle of rotation (level include angle) of the circumference of the vertical axis to the base of Supporters 94a and 94b, are carried.

[0128] In drawing 16, the sign 96 shows on behalf of the parts of generalization control / processing section 26 in drawing 2, individual processing and actuator 20a, light emitting device 14a, photo detector 15a, and half mirror 17a. With the gestalt of this operation, while reflecting the exposure light from light emitting device 14a between half mirror 17a and object optical-system 16a in drawing 2, the dichroic mirror 97 which has the property which penetrates the light intervenes, and the optical path between half mirror 17a and object optical-system 16a is bent. Thereby, object optical-system 16a is made to serve a double purpose as object optical system for collimation optical system, and exposure optical-axis 12a is in agreement with the optical axis of collimation optical system. Collimation optical system consists of object optical-system 16a and an ocular system 98, and constitutes the telescope. 99 in drawing 16 shows the eye of an operating personnel. as [turn / by this / the elements 96-97 mentioned above and 16a are fixed to a head 93, and / to the sense of arbitration / by the revolution of the circumference of said horizontal axis, and the revolution of the circumference of said vertical axis / exposure optical-axis 12a] -- **** -- it is.

[0129] Moreover, in drawing 16, the sign 101 shows on behalf of the parts of individual processing and actuator 20b in drawing 2, light emitting device 14b, photo detector 15b, and half mirror 17b. These elements are carried in the base 95 neighborhood, as shown in drawing 16, and when the sense of exposure optical-axis 12b is installed so that the datum plane of the base 95 may turn into the level surface, the physical relationship of exposure optical-axis 12b to the base 95 is being fixed so that it may become downward [of the direction of a vertical]. But as long as exposure optical-axis 12b is downward, it may incline to the direction of a vertical.

[0130] In addition, in drawing 16, the graphic display of a control unit 27 and a display 28 is omitted.

[0131] With the gestalt of this operation, if the command of the purport which measures the machine high of the total station 90 is given to generalization control / processing section 26 from a control unit 27 in advance of measurement of the position coordinate of the original measuring object 102, generalization

control / processing section 26 will give a ranging command to individual processing and actuator 20b. Individual processing and actuator 20b perform the same actuation as the case of the gestalt of said 1st operation, and gives the distance of the direction of a vertical from the co-ordinate basic origin of the total station 90 to the ground, i.e., the machine high of the total station 90, to generalization control / processing section 26. This machine high is stored in the internal memory of generalization control / processing section 26.

[0132] Next, if an operating personnel doubles the sense of a head 93 with the sense which carries out the collimation of the measuring object 102 and gives the measurement initiation command of a position coordinate to generalization control / processing section 26 from a control unit 27, generalization control / processing section 26 will give a ranging command to individual processing and actuator 20a. Individual processing and actuator 20a perform the same actuation as the case of the gestalt of said 1st operation, and gives the distance to the measuring object 102 to generalization control / processing section 26.

Moreover, generalization control / processing section 26 acquires an altitude include angle and a level include angle from said angle gauge for altitude include angles, and the angle gauge for level include angles, respectively. And generalization control / processing section 26 computes the coordinate of the measuring object 102 based on the distance, altitude include angle, and level include angle which were acquired as mentioned above. At this time, generalization control / processing section 26 computes the coordinate of the measuring object 102 on the basis of a terrestrial reference point by using the machine high acquired previously. The coordinate of the computed measuring object 102 is displayed on a display 28.

[0133] Since according to the gestalt of this operation the machine high is obtained as it mentioned above, machine high measurement does not take trouble.

[0134] In the gestalt of the 1st mentioned above thru/or the 7th operation, the time difference with the time of luminescence of exposure light and light-receiving of the reflected light may be measured with a clock counter, may be measured according to the phase contrast of a light wave, or may be measured by other approaches, and is not limited especially.

[0135] As mentioned above, although the gestalt of each operation of this invention was explained, this invention is not limited to the gestalt of these operations. For example, the number of an exposure optical axis is not limited to the example of the gestalt of each operation mentioned above.

[0136] Moreover, the deformation same with having transformed the gestalt of the 1st operation and having acquired the gestalt of the 2nd operation may be applied to the gestalt of the 3rd thru/or the 7th operation.

[0137]

[Effect of the Invention] As explained above, according to this invention, the distance measuring equipment which can search for easily the physical relationship between the distance measuring equipment which can measure easily the distance to two or more measuring objects, or two or more measuring objects etc. or the distance measuring equipment which does not necessarily

require a tripod etc., and the indoor metering device using this can be offered.
[0138] Moreover, according to this invention, the total station which machine high measurement does not take trouble can be offered.

PATENT ABSTRACTS OF JAPAN

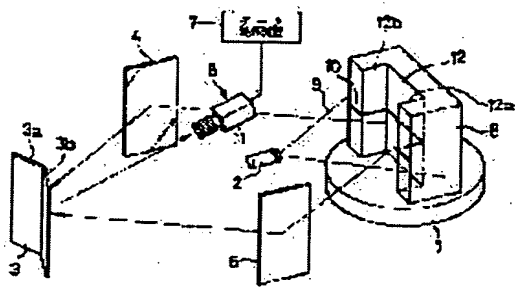
(11)Publication number : 05-322526
(43)Date of publication of application : 07.12.1993

(51)Int.Cl.

G01B 11/24

(21)Application number : 04-129058 (71)Applicant : KOYO SEIKO CO LTD
(22)Date of filing : 21.05.1992 (72)Inventor : HIYAMIZU YOSHINOBU
NISHIZAKI KATSUTOSHI

(54) THREE DIMENSIONAL FORM MEASURING APPARATUS



(57)Abstract:

PURPOSE: To solve the inconveniences due to a blind spot and to simplify the constitution of hardware and processing of data by converting a plurality of two-dimensional image data from a two-dimensional image pick-up device to three-dimensional shape data by the use of the corresponding conversion positional data.

CONSTITUTION: In order to measure the shape of an object 8, an image of a light cutting line 10 formed on each of two mirror faces of a polygon mirror 3 is photographed, and the two-dimensional image data of the two images of the cutting line 10 photographed by a camera 11 are sent to a data processing device 7. In the device 7, the two two-dimensional image data are converted to a three-dimensional shape data by the use of the corresponding conversion

positional data. While the object 8 is moved and rotated, the above manipulation is repeated, so that the three-dimensional shape of the object 8 is measured.

CLAIMS

[Claim 1] It is the three-dimension image measuring device made as [change / the two-dimensional image data of the optical cutting plane line with which slit light is irradiated at a device under test, and this slit light is formed in the front face of a device under test / into three-dimension configuration data / using conversion location data]. One slit light equipment which irradiates slit light at a device under test, the polygon mirror which has two or more mirror planes, Two or more plane mirrors which are arranged in a mutually different location and made to reflect the light from the optical cutting plane line of the front face of a device under test towards the mirror plane where a polygon mirror corresponds, One two-dimensional image pick-up equipment which picturizes simultaneously the image of an optical cutting plane line reflected in two or more mirror planes of a polygon mirror, and outputs the two-dimensional image data of each image, And the three-dimension configuration measuring device characterized by having the data processor which changes two or more two-dimensional image data from two-dimensional image pick-up equipment into three-dimension configuration data using the conversion location data corresponding to each.

DETAILED DESCRIPTION

[0001]

[Industrial Application] This invention relates to the three-dimension image measuring device made as [change / the three-dimension configuration measuring device which used the optical cutting method, and the two-dimensional image data of the optical cutting plane line with which slit light is irradiated in more detail at a device under test, and this slit light is formed in the front face of a device under test / into three-dimension configuration data / using conversion location data].

[0002]

[Description of the Prior Art] The thing equipped with two-dimensional image pick-up equipments, such as a television camera which picturizes the slit light equipment which irradiates slit light at a device under test, and the optical cutting plane line formed in a device-under-test front face as this kind of a three-dimension configuration measuring device, and outputs that two-dimensional image data, and the data processor which changes the two-dimensional image data of the optical cutting plane line from two-dimensional image pick-up equipment into three-dimension configuration data using conversion location data is known. Two-dimensional image pick-up equipment is usually formed only one.

[0003] However, it a part of optical cutting plane line which a dead angle may

arise with the configuration of a device under test, and is formed in a device-under-test front face goes into a dead angle, this cannot be picturized, therefore configuration measurement of a device under test becomes impossible in the three-dimension configuration measuring device in which two-dimensional image pick-up equipment is formed only one as mentioned above.

[0004] The three-dimension configuration measuring device using two or more two-dimensional image pick-up equipments is proposed in order to avoid the inconvenience by the above dead angles arising, for example, as shown in JP,63-9602,B etc.

[0005]

[Problem(s) to be Solved by the Invention] As mentioned above, in the three-dimension configuration measuring device using two or more two-dimensional image pick-up equipments, it becomes cost high, a configuration is complicated in respect of hardware, and complicated data processing, such as parallel data processing, is needed also in respect of software.

[0006] The object of this invention solves the above-mentioned problem, and can cancel the inconvenience by the dead angle, moreover, it is simple for data processing by the configuration and software of hardware, and it is for cost to also offer a cheap three-dimension configuration measuring device.

[0007]

[Means for Solving the Problem] The three-dimension configuration measuring device by this invention irradiates slit light at a device under test. It is the three-dimension image measuring device made as [change / the two-dimensional image data of the optical cutting plane line with which this slit light is formed in the front face of a device under test / into three-dimension configuration data / using conversion location data]. One slit light equipment which irradiates slit light at a device under test, the polygon mirror which has two or more mirror planes, Two or more plane mirrors which are arranged in a mutually different location and made to reflect the light from the optical cutting plane line of the front face of a device under test towards the mirror plane where a polygon mirror corresponds, One two-dimensional image pick-up equipment which picturizes simultaneously the image of an optical cutting plane line reflected in two or more mirror planes of a polygon mirror, and outputs the two-dimensional image data of each image, And it is characterized by having the data processor which changes two or more two-dimensional image data from two-dimensional image pick-up equipment into three-dimension configuration data using the conversion location data corresponding to each.

[0008]

[Function] Since the optical cutting plane line of a device under test is reflected by two or more plane mirrors arranged in a mutually different location, it is projected on two or more mirror planes of a polygon mirror and two or more of these images are picturized by two-dimensional image pick-up equipment, the two-dimensional image data which looked at the optical cutting plane line from the direction where plurality differs is obtained. Therefore, even if it is a case with the complicated configuration of a device under test, the two-dimensional image data of the optical whole cutting plane line formed on the surface of a device

under test can be obtained, and configuration measurement of a device under test can be performed by this.

[0009]

[Example] Hereafter, the example of this invention is explained with reference to a drawing.

[0010] Drawing 1 shows the whole three-dimension configuration measuring device outline configuration, and this equipment is a device-under-test stage (1). Slit light equipment (2) One polygon mirror (3) Two plane mirrors (4), (5), and one two-dimensional image pick-up equipment (6) And data processor (7) It has.

[0011] Stage (1) Device under test (8) It is for carrying, and while being moved to two horizontal directions and perpendicularly it intersects mutually by the suitable means which is not illustrated, it is rotated centering on vertical axes.

[0012] Slit light equipment (2) LD (laser diode), a cylindrical lens, etc. which are not illustrated are used, and it is a device under test (8). Slit light (9) It is for irradiating.

[0013] Polygon mirror (3) It has two mirror planes (3a) (3b), and is light equipment (2) at this example. It receives and is a device under test (8). It is arranged in the location of an opposite hand. Two plane mirrors (4) and (5) are arranged in a mutually different location. And the 1st plane mirror (4) Slit light (9) Device under test (8) It is a polygon mirror (3) about the light from the optical cutting plane line (10) formed in a front face. It is made to reflect towards the 1st mirror plane (3a). The 2nd plane mirror (5) It is a polygon mirror (3) about the light from an optical cutting plane line (10). It is made to reflect towards the 2nd mirror plane (3b). Consequently, in the 1st mirror plane (3a) of a polygon mirror (3), it is the 1st plane mirror (4) about an optical cutting plane line (10). From a direction, the seen image is reflected and it is a polygon mirror (3). The image which looked at the optical cutting plane line (10) from the direction of the 2nd mirror plane (3b) is reflected in the 2nd mirror plane (3b).

[0014] Two-dimensional image pick-up equipment (6) Polygon mirror (3) The image of an optical cutting plane line (10) reflected in two mirror planes (3a) (3b) is picturized simultaneously, and it is a data processor (7) about the two-dimensional image data of each image. It is for outputting and has the television camera (11) which has a two-dimensional image sensor.

[0015] Data processor (7) Polygon mirror (3) It is for changing the two-dimensional image data of two images of the optical cutting plane line (10) from two mirror planes (3a) (3b) into three-dimension configuration data using the conversion location data corresponding to each, for example, is constituted by the microcomputer (microcomputer). It is obtained by the calibration and two conversion location data are data processors (7). Memory memorizes.

[0016] In the above-mentioned three-dimension configuration measuring device, a calibration is performed, the conversion location data for changing two two-dimensional image data from a television camera (11) into three-dimension configuration data, respectively are called for in advance of measurement, and these are data processors (7). It memorizes.

[0017] Device under test (8) When measuring a configuration, it is a polygon mirror (3) by the television camera (11). The two-dimensional image data of two

images of the optical cutting plane line (10) which the image of an optical cutting plane line (10) reflected in two mirror planes was picturized, and was picturized with the television camera (11) is a data processor (7). It is sent. Data processor (7) These two two-dimensional image data is changed into three-dimension configuration data using the conversion location data then corresponding to each. And device under test (8) It is a device under test (8) by repeating such actuation, performing migration and a revolution. A three-dimension configuration is measured.

[0018] Device under test by which the groove section (12) was formed in the transverse plane as shown in drawing 1 (8) When picturizing the optical cutting plane line (10) formed in a front face with one television camera, even if it picturizes from which direction, it is impossible for a dead angle to arise and to picturize the optical whole cutting plane line (10). Namely, light equipment (2) If it picturizes from a direction, the optical cutting plane line (10) of the part of the both-sides side (12a) (12b) of the groove section (12) cannot be picturized. The 1st plane mirror (4) If it picturizes from a direction, it is the 1st side face (12a) of the groove section (12). The optical cutting plane line (10) of a part is the 2nd side face (12b), although it can picturize. The optical cutting plane line (10) of a part cannot be picturized. On the contrary, the 2nd plane mirror (5) If it picturizes from a direction, it is the 2nd side face (12b) of the groove section (12). The optical cutting plane line (10) of a part is the 1st side face (12a), although it can picturize. The optical cutting plane line (10) of a part cannot be picturized.

[0019] On the other hand, in the case of the above-mentioned example, it is a polygon mirror (3). In the 1st mirror plane (3a), it is the 1st plane mirror (4). Since the image of an optical cutting plane line (10) seen from the direction is reflected, in this, it is the 1st side face (12a) of the groove section (12). The image of the optical cutting plane line (10) of a part is reflected. Moreover, polygon mirror (3) In the 2nd mirror plane (3b), it is the 2nd plane mirror (5). Since the image of an optical cutting plane line (10) seen from the direction is reflected, in this, it is the 2nd side face (12b) of the groove section (12). The image of the optical cutting plane line (10) of a part is reflected. Therefore, polygon mirror (3) When two mirror planes (3a) (3b) are doubled, by having reflected the image of the optical whole cutting plane line (10), and picturizing these simultaneously with a television camera (11), the two-dimensional image data of the optical whole cutting plane line (10) can be obtained, and it is a device under test (8). Three-dimension configuration measurement can be performed.

[0020] At the above-mentioned example, it is a polygon mirror (3). Although the number of mirror planes (3a) (3b) and the number of a plane mirror (4) and (5) are two, if required by the configuration of a device under test, it is good as for three or more in these.

[0021]

[Effect of the Invention] According to the three-dimension configuration measuring device of this invention, the optical whole cutting plane line formed in a device-under-test front face using one television camera can be picturized as mentioned above, therefore the problem of the dead angle by the configuration of a device under test is solved, and configuration measurement of a device under

test can be performed. And since only one television camera is used, data processing by the configuration and software of hardware is also easy, and cost becomes cheap.

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号
特開2003-156333
(P2003-156333A)

(43) 公開日 平成15年5月30日 (2003.5.30)

(51) Int.Cl. ⁷	識別記号	F I	テ-マ-ト* (参考)
G 0 1 C 15/00	1 0 3	G 0 1 C 15/00	1 0 3 A 2 F 1 1 2
3/06		3/06	Z 5 J 0 8 4
G 0 1 S 17/08		G 0 1 S 17/08	

審査請求 未請求 請求項の数23 O L (全 17 頁)

(21) 出願番号 特願2001-355472(P2001-355472)

(22) 出願日 平成13年11月21日 (2001.11.21)

(71) 出願人 000004112
株式会社ニコン
東京都千代田区丸の内3丁目2番3号
(72) 発明者 青木 滋
東京都千代田区丸の内3丁目2番3号 株
式会社ニコン本社内
(74) 代理人 100096770
弁理士 四宮 通

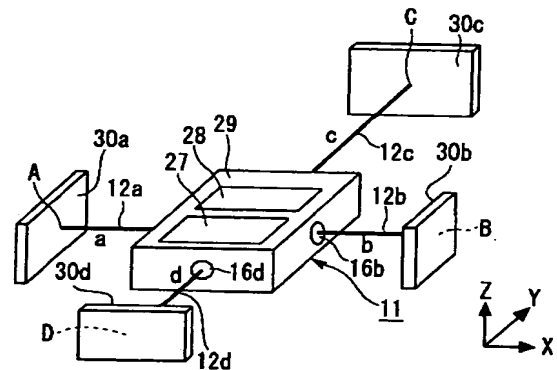
最終頁に続く

(54) 【発明の名称】 測距装置、並びに、これを用いた室内計測装置及びトータルステーション

(57) 【要約】

【課題】 複数の測定対象間の位置関係等を簡単に求めることができるとともに必ずしも三脚等を要しない、測距装置を提供する。

【解決手段】 送受信光学系は、複数の照射光軸12a～12dを持ち、照射光軸12a～12dに沿って照射光を照射し、各照射光に対応する各反射光を受信する。距離取得部は、送受信光学系により受信された前記各反射光に基づいて、各照射光軸12a～12dの延長上に存在する各測定対象30a～30bまでの各距離a～dをそれぞれ得る。照射光軸12a～12dは、所定の基準平面内又は該所定の基準平面と略平行な平面内に含まれ、照射光軸12a～12dを前記基準平面に写像したときに、前記基準平面内で略90°ずつの角度間隔を持つ。



【特許請求の範囲】

【請求項1】 複数の照射光軸を持つ送受信光学系であって、前記複数の照射光軸に沿って光をそれぞれ同時に又は異なるタイミングで照射し、前記複数の照射光軸にそれぞれ沿って照射された各照射光に対応する各反射光をそれぞれ同時に又は異なるタイミングで受信する送受信光学系と、

前記送受信光学系により受信された前記各反射光に基づいて、前記各照射光軸の延長上に存在する各測定対象までの各距離をそれぞれ得る距離取得部と、
を備え、

前記複数の照射光軸のうちの2本以上の照射光軸は、互いに異なる向きとなるように互いの相対的な位置関係が固定されたことを特徴とする測距装置。

【請求項2】 前記距離取得部により得られた前記各測定対象までの各距離に基づいて、前記各測定対象間の相対的な位置関係を求める手段を備えたことを特徴とする請求項1記載の測距装置。

【請求項3】 前記相対的な位置関係を求める手段は、前記各測定対象間の距離を求める手段を含むことを特徴とする請求項2記載の測距装置。

【請求項4】 前記相対的な位置関係を求める手段は、前記各測定対象の相対座標を求める手段を含むことを特徴とする請求項2又は3記載の測距装置。

【請求項5】 前記各照射光軸にそれぞれ対応する各測定対象の位置をそれぞれ含みかつ予め想定された2次元又は3次元の形状に関する所定の値を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたことを特徴とする請求項1乃至4のいずれかに記載の測距装置。

【請求項6】 前記2本以上の照射光軸は、互いの向きが略90°をなす2本の照射光軸を含むことを特徴とする請求項1乃至5のいずれかに記載の測距装置。

【請求項7】 前記2本以上の照射光軸は、互いの向きが略180°をなす2本の照射光軸を含むことを特徴とする請求項1乃至5のいずれかに記載の測距装置。

【請求項8】 前記2本以上の照射光軸は、所定の基準平面内又は該所定の基準平面と略平行な平面内に含まれる4本の照射光軸を含み、
前記4本の照射光軸の向きは、前記4本の照射光軸を前記基準平面に写像したときに、前記基準平面内で略90°ずつの角度間隔を持つことを特徴とする請求項1乃至5のいずれかに記載の測距装置。

【請求項9】 前記4本の照射光軸にそれぞれ対応する4つの測定対象の位置を前記基準平面に写像した前記基準平面内の4つの位置をそれぞれ各辺上に含みかつ予め想定された形状を持つ前記基準平面内の四角形の各辺の長さに相当する長さを、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたことを特徴とする請求項8記載の測距装置。

【請求項10】 前記4本の照射光軸にそれぞれ対応する4つの測定対象の位置を前記基準平面に写像した前記基準平面内の4つの位置をそれぞれ各辺上に含みかつ予め想定された形状を持つ前記基準平面内の四角形の各頂点に相当する位置の相対座標を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたことを特徴とする請求項8又は9記載の測距装置。

【請求項11】 前記4本の照射光軸にそれぞれ対応する4つの測定対象の位置を前記基準平面に写像した前記基準平面内の4つの位置をそれぞれ各辺上に含みかつ予め想定された形状を持つ前記基準平面内の四角形の面積に相当する面積を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたことを特徴とする請求項8乃至10のいずれかに記載の測距装置。

【請求項12】 前記予め想定された形状が長方形であることを特徴とする請求項8乃至11のいずれかに記載の測距装置。

【請求項13】 前記2本以上の照射光軸は、所定の基準平面内又は該所定の基準平面と略平行な平面内に含まれる4本の照射光軸と、互いの向きが略180°をなすとともに前記基準平面に対してそれぞれ略90°をなす2本の照射光軸とを含み、

前記4本の照射光軸の向きは、前記4本の照射光軸を前記基準平面に写像したときに、前記基準平面内で略90°ずつの角度間隔を持つことを特徴とする請求項1乃至5のいずれかに記載の測距装置。

【請求項14】 前記4本の照射光軸及び前記2本の照射光軸にそれぞれ対応する6つの測定対象の位置をそれぞれ各面上に含みかつ予め想定された形状を持つ六面体の各辺の長さに相当する長さを、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたことを特徴とする請求項13記載の測距装置。

【請求項15】 前記4本の照射光軸及び前記2本の照射光軸にそれぞれ対応する6つの測定対象の位置をそれぞれ各面上に含みかつ予め想定された形状を持つ六面体の各頂点に相当する位置の相対座標を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたことを特徴とする請求項13又は14記載の測距装置。

【請求項16】 前記4本の照射光軸及び前記2本の照射光軸にそれぞれ対応する6つの測定対象の位置をそれぞれ各面上に含みかつ予め想定された形状を持つ六面体の各面の面積に相当する面積を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたことを特徴とする請求項13乃至15のいずれかに記載の測距装置。

【請求項17】 前記4本の照射光軸及び前記2本の照

射光軸にそれぞれ対応する6つの測定対象の位置をそれぞれ各面上に含みかつ予め想定された形状を持つ六面体の体積に相当する体積を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたことを特徴とする請求項13乃至16のいずれかに記載の測距装置。

【請求項18】 前記予め想定された形状が直方体であることを特徴とする請求項14乃至17のいずれかに記載の測距装置。

【請求項19】 前記複数の照射光軸は、前記2本以上の照射光軸以外に少なくとも1本の照射光軸を含み、前記少なくとも1本の照射光軸の向きは、前記2本以上の照射光軸の向きに対して相対的に変更可能であり、前記2本以上の照射光軸のいずれかに対する前記少なくとも1本の照射光軸の相対的な向きを検出する検出手段、又は、前記相対的な向きを示すデータを入力する入力手段を備えたことを特徴とする請求項1乃至18のいずれかに記載の測距装置。

【請求項20】 室内に関する所定の計測を行う室内計測装置であって、請求項1乃至19のいずれかに記載の測距装置を備えたことを特徴とする室内計測装置。

【請求項21】 複数の照射光軸を持つ送受信光学系であって、前記複数の照射光軸に沿って光をそれぞれ同時に又は異なるタイミングで照射し、前記複数の照射光軸にそれぞれ沿って照射された各照射光に対応する各反射光をそれぞれ同時に又は異なるタイミングで受信する送受信光学系と、

前記送受信光学系により受信された前記各反射光に基づいて、前記各照射光軸の延長上に存在する各測定対象までの各距離をそれぞれ得る距離取得部と、

を備え、
前記複数の照射光軸のうちの少なくとも1本の照射光軸の向きが、他の少なくとも1本の照射光軸の向きに対して相対的に変更可能であり、

前記少なくとも1本の照射光軸の前記他の少なくとも1本の照射光軸に対する相対的な向きを検出する検出手段、又は、前記相対的な向きを示すデータを入力する入力手段を備えたことを特徴とする測距装置。

【請求項22】 請求項21記載の測距装置を備えたトータルステーションであって、
前記他の少なくとも1本の照射光軸が下向きであり、
前記他の少なくとも1本の照射光軸に関連して前記距離取得部により得られた距離に基づいて、当該トータルステーションの機械高を得ることを特徴とするトータルステーション。

【請求項23】 視準光学系を備え、前記少なくとも1本の照射光軸が視準光学系の光軸と一致したことを特徴とする請求項22記載のトータルステーション。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、測距装置、並びに、これを用いた室内計測装置及びトータルステーション（測角測距機）に関するものである。

【0002】

【従来の技術】従来から、測量などの分野において、以下に説明するような測距装置及びこれを有するトータルステーションが用いられている。

【0003】この従来の測距装置は、(a)単一の照射光軸のみを持ち前記照射光軸に沿って赤外光等の光を照射し、前記照射光軸に沿って照射された照射光に対応する反射光を受信する送受信光学系と、(b)前記送受信光学系により受信された反射光に基づいて、前記照射光軸の延長上に存在する測定対象までの距離を得る距離取得部と、を備えたものである。測距の原理は種々知られているが、例えば、距離取得部は、照射光の発光時と測定対象からの反射光の受光時との時間差に基づいて、測定対象までの距離を求める。

【0004】従来のトータルステーションは、このような従来の測距装置と、照射光軸の鉛直軸回りの水平角度と仰俯角度（高度角度）を測定する測角装置とを、組み合わせたものである。トータルステーションでは、通常三脚等に搭載して使用されるため、地上からの機械原点の高さ（機械高）を知る必要がある。従来のトータルステーションでは、機械高は測定者によって巻尺等により測定され、そのデータが操作パネル等の入力装置により入力されていた。

【0005】

【発明が解決しようとする課題】しかしながら、前述した従来の測定装置や従来のトータルステーションでは、単一の照射光軸しか持っていなかったため、複数の測定対象間の位置関係等（例えば、複数の測定対象間の距離）を求める場合、順次に、複数の測定対象毎に照射光軸の方向合わせをして測距する必要がある。このため、照射光軸の方向合わせに時間と手数を要し、複数の測定対象間の位置関係等を簡単に求めることができない。また、測定者が、測距により得られた各測定対象までの各距離を、当該装置に内蔵する演算装置（マイクロコンピュータ等）に順次入力して、演算装置に複数の測定対象間の位置関係等を演算させなければならない、この点からも時間と手数を要する。さらに、照射光軸の方向合わせを行うためには、回転台や三脚等を要し、装置全体として大型化し重量が増大するとともにコストアップも免れない。

【0006】これらの点について、室内計測の例を挙げて説明する。例えば、オフィスや住宅などのインテリアに関連して、室内の各部の寸法、床面積、壁の面積、部屋の体積（容積）などを計測することが要請される場合がある。これらを計測すると、例えば、部屋の図面を書き起こしたり、必要な絨毯やカーテン等の寸法やタイルの枚数等を求めたり、室内に配置し得る家具等の選定や

そのレイアウト等を決定したりすることができる。このような室内計測のために、前述した従来の測定装置や従来のトータルステーションを用いる例について、図17及び図18を参照して説明する。

【0007】図17は、従来の測定装置111による測定の様子を模式的に示す概略斜視図である。この測定装置111は、回転台を有する三脚112上に搭載されている。測定装置111に内蔵された送受信光学系（図示せず）は、1本の照射光軸113のみを持っている。図18は、従来のトータルステーション114による測定の様子を模式的に示す概略斜視図である。このトータルステーション114の本体115は、三脚116上に搭載されている。このトータルステーション114に内蔵された送受信光学系は、1本の照射光軸117のみを持っている。図17及び図18において、118、119はそれぞれ測定対象としての室内の互いに対向する壁であり、測距装置111及びトータルステーション114はそれぞれ室内に置かれている。

【0008】図17に示すように、測距装置111を用いて壁118、119間の距離を測定しようとするときには、まず、当該装置111を室内に置いてその照射光軸113を一方の壁118に向け、当該装置111から当該一方の壁118までの距離を測定する。この距離は表示器120に表示され、測定者はこれを見てメモしておく。次に、当該装置111の向きを180°変えてその照射光軸113を反対側の壁119に向け、当該装置111から当該反対側の壁119までの距離を測定する。この距離は表示器120に表示され、測定者はこれを見てメモしておく。その後、測定装置111に搭載された電卓機能を用いて、操作パネル121によりメモした壁118、119までの距離を入力して両距離を加算させる。その加算結果が、対向する壁118、119間の距離であり、表示器120に表示される。図18に示すように、トータルステーション4を用いて壁118、119間の距離を測定しようとする場合も、同様である。

【0009】このように、従来の測距装置111やトータルステーション114を用いて壁118、119間の距離を測定する場合には、順次に、測定対象としての壁118、119毎に照射光軸113、117の方向合わせをして測距しなければならず、その方向合わせに時間と手数を要し、壁118、119の距離を簡単に求めることができない。また、測定者が、測距により得られた各壁118、119までの各距離を、当該装置に内蔵する演算装置（マイクロコンピュータ等）に順次入力して、演算装置に壁118、119間の距離を演算させなければならず、この点からも時間と手数を要する。さらに、照射光軸113、117の方向合わせを行うためには、回転台や三脚112、116等を要し、装置全体として大型化し重量が増大するとともにコストアップも免れない。

【0010】このような事情は、室内計測のみならず、複数の測定対象間の位置関係等を測定する他の場合にも同様である。

【0011】また、前記従来のトータルステーション114では、前述したように、機械高が測定者によって巻尺等により測定され、そのデータが操作パネル等の入力装置により入力されていたので、機械高の測定に手数を要していた。

【0012】本発明は、前述したような事情に鑑みてなされたもので、複数の測定対象間の位置関係等を簡単に求めることができるとともに必ずしも三脚等を要しない測距装置及びこれを用いた室内計測装置を提供することを目的とする。

【0013】また、本発明は、機械高の測定に手数を要しないトータルステーションを提供することを目的とする。

【0014】

【課題を解決するための手段】前記課題を解決するため、本発明の第1の態様による測距装置は、複数の照射光軸を持つ送受信光学系であって、前記複数の照射光軸に沿って光をそれぞれ同時に又は異なるタイミングで照射し、前記複数の照射光軸にそれぞれ沿って照射された各照射光に対応する各反射光をそれぞれ同時に又は異なるタイミングで受信する送受信光学系と、前記送受信光学系により受信された前記各反射光に基づいて、前記各照射光軸の延長上に存在する各測定対象までの各距離をそれぞれ得る距離取得部と、を備え、前記複数の照射光軸のうちの2本以上の照射光軸は、互いに異なる向きとなるように互いの相対的な位置関係が固定されたものである。

【0015】前記距離取得部は、例えば、照射光の発光時と測定対象からの反射光の受光時との時間差に基づいて、測定対象までの距離を求める。もっとも、本発明で採用し得る測距原理は、このような時間差によるものに限定されない。この点は、後述する各態様についても同様である。

【0016】本発明の第2の態様による測距装置は、前記第1の態様において、前記距離取得部により得られた前記各測定対象までの各距離に基づいて、前記各測定対象間の相対的な位置関係を求める手段を備えたものである。

【0017】本発明の第3の態様による測距装置は、前記第2の態様において、前記相対的な位置関係を求める手段は、前記各測定対象間の距離を求める手段を含むものである。

【0018】本発明の第4の態様による測距装置は、前記第2又は第3の態様において、前記相対的な位置関係を求める手段は、前記各測定対象の相対座標を求める手段を含むものである。

【0019】本発明の第5の態様による測距装置は、前

記第1乃至第4のいずれかの態様において、前記各照射光軸にそれぞれ対応する各測定対象の位置をそれぞれ含みかつ予め想定された2次元又は3次元の形状に関する所定の値を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたものである。

【0020】本発明の第6の態様による測距装置は、前記第1乃至第5のいずれかの態様において、前記2本以上の照射光軸は、互いの向きが略90°をなす2本の照射光軸を含むものである。

【0021】本発明の第7の態様による測距装置は、前記第1乃至第5のいずれかの態様において、前記2本以上の照射光軸は、互いの向きが略180°をなす2本の照射光軸を含むものである。

【0022】本発明の第8の態様による測距装置は、前記第1乃至第5のいずれかの態様において、前記2本以上の照射光軸は、所定の基準平面内又は該所定の基準平面と略平行な平面内に含まれる4本の照射光軸を含み、前記4本の照射光軸の向きは、前記4本の照射光軸を前記基準平面に写像したときに、前記基準平面内で略90°ずつの角度間隔を持つものである。

【0023】本発明の第9の態様による測距装置は、前記第8の態様において、前記4本の照射光軸にそれぞれ対応する4つの測定対象の位置を前記基準平面に写像した前記基準平面内の4つの位置をそれぞれ各辺上に含みかつ予め想定された形状を持つ前記基準平面内の四角形の各辺の長さに相当する長さを、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたものである。

【0024】本発明の第10の態様による測距装置は、前記第8又は第9の態様において、前記4本の照射光軸にそれぞれ対応する4つの測定対象の位置を前記基準平面に写像した前記基準平面内の4つの位置をそれぞれ各辺上に含みかつ予め想定された形状を持つ前記基準平面内の四角形の各頂点に相当する位置の相対座標を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたものである。

【0025】本発明の第11の態様による測距装置は、前記第8乃至第10のいずれかの態様において、前記4本の照射光軸にそれぞれ対応する4つの測定対象の位置を前記基準平面に写像した前記基準平面内の4つの位置をそれぞれ各辺上に含みかつ予め想定された形状を持つ前記基準平面内の四角形の面積に相当する面積を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたものである。

【0026】本発明の第12の態様による測距装置は、前記第8乃至第11のいずれかの態様において、前記予め想定された形状が長方形であるものである。

【0027】本発明の第13の態様による測距装置は、前記第1乃至第5のいずれかの態様において、前記2本

以上の照射光軸は、所定の基準平面内又は該所定の基準平面と略平行な平面内に含まれる4本の照射光軸と、互いの向きが略180°をなすとともに前記基準平面に対してそれぞれ略90°をなす2本の照射光軸とを含み、前記4本の照射光軸の向きは、前記4本の照射光軸を前記基準平面に写像したときに、前記基準平面内で略90°ずつの角度間隔を持つものである。

【0028】本発明の第14の態様による測距装置は、前記第13の態様において、前記4本の照射光軸及び前記2本の照射光軸にそれぞれ対応する6つの測定対象の位置をそれぞれ各面上に含みかつ予め想定された形状を持つ六面体の各辺の長さに相当する長さを、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたものである。

【0029】本発明の第15の態様による測距装置は、前記第13又は第14の態様において、前記4本の照射光軸及び前記2本の照射光軸にそれぞれ対応する6つの測定対象の位置をそれぞれ各面上に含みかつ予め想定された形状を持つ六面体の各頂点に相当する位置の相対座標を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたものである。

【0030】本発明の第16の態様による測距装置は、前記第13乃至第15のいずれかの態様において、前記4本の照射光軸及び前記2本の照射光軸にそれぞれ対応する6つの測定対象の位置をそれぞれ各面上に含みかつ予め想定された形状を持つ六面体の各面の面積に相当する面積を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたものである。

【0031】本発明の第17の態様による測距装置は、前記第13乃至第16のいずれかの態様において、前記4本の照射光軸及び前記2本の照射光軸にそれぞれ対応する6つの測定対象の位置をそれぞれ各面上に含みかつ予め想定された形状を持つ六面体の体積に相当する体積を、前記距離取得部により得られた前記各測定対象までの各距離に基づいて求める手段を備えたものである。

【0032】本発明の第18の態様による測距装置は、前記第14乃至第17のいずれかの態様において、前記予め想定された形状が直方体であるものである。

【0033】本発明の第19の態様による測距装置は、前記第1乃至第18のいずれかの態様において、前記複数の照射光軸は、前記2本以上の照射光軸以外に少なくとも1本の照射光軸を含み、前記少なくとも1本の照射光軸の向きは、前記2本以上の照射光軸の向きに対して相対的に変更可能であり、前記2本以上の照射光軸のいずれかに対する前記少なくとも1本の照射光軸の相対的な向きを検出する検出手段、又は、前記相対的な向きを示すデータを入力する入力手段を備えたものである。

【0034】本発明の第20の態様による室内計測装置は、室内に関する所定の計測を行う室内計測装置であつ

て、請求項1乃至19のいずれかに記載の測距装置を備えたものである。

【0035】本発明の第21の態様による測距装置は、複数の照射光軸を持つ送受信光学系であって、前記複数の照射光軸に沿って光をそれぞれ同時に又は異なるタイミングで照射し、前記複数の照射光軸にそれぞれ沿って照射された各照射光に対応する各反射光をそれぞれ同時に又は異なるタイミングで受信する送受信光学系と、前記送受信光学系により受信された前記各反射光に基づいて、前記各照射光軸の延長上に存在する各測定対象までの各距離をそれぞれ得る距離取得部と、を備え、前記複数の照射光軸のうちの少なくとも1本の照射光軸の向きが、他の少なくとも1本の照射光軸の向きに対して相対的に変更可能であり、前記少なくとも1本の照射光軸の前記他の少なくとも1本の照射光軸に対する相対的な向きを検出する検出手段、又は、前記相対的な向きを示すデータを入力する入力手段を備えたものである。

【0036】本発明の第22の態様によるトータルステーションは、前記第21の態様による測距装置を備えたトータルステーションであって、前記他の少なくとも1本の照射光軸が下向きであり、前記他の少なくとも1本の照射光軸に関連して前記距離取得部により得られた距離に基づいて、当該トータルステーションの機械高を得るものである。

【0037】本発明の第23の態様によるトータルステーションは、前記第22の態様において、視準光学系を備え、前記少なくとも1本の照射光軸が視準光学系の光軸と一致したものである。

【0038】

【発明の実施の形態】以下、本発明による測距装置、並びに、これを用いた室内計測装置及びトータルステーションについて、図面を参照して説明する。

【0039】〔第1の実施の形態〕

【0040】図1は、本発明の第1の実施の形態による測距装置11を室内計測装置として用いた場合の測定の様子を模式的に示す概略斜視図である。図2は、本実施の形態による測距装置11を示す概略構成図である。図3は、本実施の形態による測距装置11の動作の一例を示す概略フローチャートである。図4は、本実施の形態による測距装置11による演算内容を説明するための説明図である。図1及び図4において、測距装置11を基準として定めた互いに直交するX軸、Y軸及びZ軸を定義する（後述する図についても同様である。）。また、X軸方向のうち矢印の向きを+X方向、その反対の向きを-X方向と呼ぶ。Z軸方向及びY軸方向についても同様である。

【0041】本実施の形態による測距装置11は、図1及び図2に示すように、4本の照射光軸12a~12dを持つ送受信光学系を備えている。本実施の形態では、この送受信光学系は、照射光軸12a~12dに対応し

てそれぞれ設けられた4つの個別送受信光学系13a~13dで構成されている。

【0042】本実施の形態では、個別送受信光学系13aは、赤外LEDやレーザ等の発光素子14aと、受光素子15aと、対物光学系16aと、ハーフミラー17aとを有している。発光素子14aから発光した照射光がハーフミラー17aを透過し対物光学系16aを経て照射光軸12aに沿って照射される。この照射光が照射光軸12aの延長上に存在する測定対象（図1に示す例では、壁30a）で反射され、その反射光が、照射光軸12aに沿って戻り、対物光学系16aを経てハーフミラー17aにより反射された後に受光素子15aにより受光される。送受信光学系13aの構成はこのような構成に限定されるものではなく、照射光軸12aの後述する配置を実現し得るように、必要に応じて光ファイバ等が適宜用いられる。また、本実施の形態では、反射光を受光する受光光軸が照射光軸12aと一致するように構成されているが、受光光軸が照射光軸からずれるように構成してもよい。

【0043】各個別送受信光学系13b~13cも個別送受信光学系13aと同様に構成され、個別送受信光学系13bは前記要素14a~17aに対応する要素14b~17bを有し、個別送受信光学系13cは前記要素14a~17aに対応する要素14c~17cを有し、個別送受信光学系13dは前記要素14a~17aに対応する要素14d~17dを有している。

【0044】本実施の形態による測距装置11は、前述した送受信光学系の他に、各個別送受信光学系13a~13bに対してそれぞれ発光駆動制御を行うとともに反射光の受光に基づき測定対象までの距離を得る測距演算処理を行う各個別処理・駆動部20a~20dと、操作部27からの指令に回答して各個別処理・駆動部20a~20dを統括制御するとともに各個別処理・駆動部20a~20dから得られる距離に基づいて後述する演算処理などを行う統括制御・処理部26と、測定者が各種の指令等を入力するための操作部27と、測定結果等を表示する液晶表示器等の表示部28と、を備えている。統括制御・処理部26は、例えば、CPU等を用いて構成される。以上説明した各構成要素は、筐体29内に又は筐体29の表面部に設けられている。

【0045】個別処理・駆動部20aは、例えばCPU等で構成される個別制御・処理部21aと、例えばデジタル回路等で構成される時間測定回路22aと、発光素子14aを駆動する発光素子駆動回路23aと、受光素子15aからの受光信号を増幅する増幅回路24aと、増幅された受光信号をA/D変換するA/D変換器25aと、を有している。個別制御・処理部21aは、統括制御・処理部26からの指令に回答して、測距開始信号を時間測定回路22aに与える。時間測定回路22aは、この測距開始信号に回答して、発光素子駆動回路2

3aを作動させて発光素子14aを発光させ、照射光軸12aに沿って照射光を照射させる。受光素子15aからの受光信号（照射光が測定対象で反射した反射光の受光信号）は、増幅回路24aで増幅され更にA/D変換器25aでA/D変換された後に、時間測定回路22aに入力される。時間測定回路22aは、照射光の発光時と反射光の受光時との時間差を測定し、その時間差を個別制御・処理部21aに与える。個別制御・処理部21aは、時間測定回路22aから得られた時間差に基づいて、測距装置11の機械原点Oから照射光軸12aの延長上に存在する測定対象までの距離aを、演算により求める。この距離aは、個別処理駆動部20aから統括制御・処理部26に供給される。

【0046】図面には示していないが、各個別処理・駆動部20b～20dも、前述した個別処理・駆動部20aと同様に構成されている。

【0047】照射光軸12a～12dは、互いに異なる向きとなるように互いの相対的な位置関係が固定されている。本実施の形態では、図1に示すように、XY平面と平行な所定の基準平面内に含まれ、照射光軸12aの向きは-X方向、照射光軸12bの向きは+X方向、照射光軸12cの向きは+Y方向、照射光軸12dの向きは-Y方向とされ、照射光軸12a～12dの向きは前記基準平面内で90°ずつの角度間隔を持っている。また、本実施の形態では、照射光軸12aと照射光軸12bとは同一直線上にあり、照射光軸12cと照射光軸12dとは同一直線上にあり、両直線の交点が測距装置11の機械原点Oとなっている。

【0048】本実施の形態では、筐体29は直方体状に構成され、筐体29の図1中の上面及び下面がXY平面と平行とされ、筐体29の図1中の左側面及び右側面がYZ平面と平行とされ、筐体29の図1中の手前側の側面及び奥側の側面がXZ平面と平行とされている。したがって、照射光軸12a～12dが筐体29の対応する側面とそれぞれ直交している。

【0049】次に、本実施の形態による測距装置11の動作の一例について、図1乃至図4、特に図3を参照して説明する。

【0050】例えば、本実施の形態による測距装置11を用いて室内計測を行う場合には、図1に示すように、測距装置11を室内に置き、照射光軸12a～12dが室内の各測定対象としての壁30a～30dに対してそれぞれほぼ垂直となるように、測距装置11の向きを決める。このとき、前述したように照射光軸12a～12dが筐体29の対応する側面とそれぞれ直交しているので、これらの側面を目安にして又はガイドにすることによって、測距装置11の向きを容易に設定することができる。例えば、筐体29の1つの側面を1つの壁に押し付けてもよい。理想的には照射光軸12a～12dが室内の壁30a～30dに対してそれぞれ厳密に垂直であ

ることが好ましいが、その向きが多少ずれても測定精度にはあまり影響がない。ここでは、計測対象となる部屋は、直方体であるものとし、互いに対向する壁30a、30bが互いに平行であり、互いに対向する壁30c、30dが互いに平行であり、壁30a、30bと壁30c、30dとは直交しているものとする。測距装置11は、例えば単に床や机などの上に置くだけでよく、必ずしも三脚等に搭載する必要はない。勿論、必要に応じて、測距装置11を三脚等に搭載してもよい。

【0051】図1に示すように、壁30a～30dにおける照射光軸12a～12dの延長上の点をそれぞれA、B、C、Dとする。これらの点と機械原点Oとの関係は、Z軸方向から前記基準平面に写像して見ると、図4に示すようになっている。

【0052】測定者が、測距装置11をこのように配置した後、操作部27を操作して測定の開始指令を与えると、統括制御・処理部26は、この指令にตอบสนองして、各個別処理・駆動部20a～20dにそれぞれ測距開始指令を与える。各個別処理・駆動部20a～20dは、これらの測距開始指令にตอบสนองして前述した動作を行い、機械原点Oから各壁30a～30dの各点A、B、C、Dまでの各距離a～dをそれぞれ統括制御・処理部26に供給する（図3中のステップS1）。なお、統括制御・処理部26は、個別処理・駆動部20a～20dを同時に作動させるように制御してもよいし、時分割的に順次に作動させるようにしてもよい。

【0053】次に、統括制御・処理部26は、個別処理・駆動部20a～20dから各距離a～dが得られると、各距離a～dに基づいて、図4中の長方形GHJKの各辺の寸法L1、L2を算出する（図3中のステップS2）。長方形GHJKは、点A、B、C、Dを前記基準平面に写像した点（本実施の形態では、これらの写像点は点A、B、C、D自体である。）をそれぞれ各辺上に含み、かつ、予め想定された形状として長方形（2次元形状）を持つ、四角形である。各辺の寸法L1、L2は、次の数1及び数2により算出することができることは、明らかである。

【0054】

【数1】 $L1 = a + b$

【0055】

【数2】 $L2 = c + d$

【0056】次いで、統括制御・処理部26は、各距離a～dに基づいて、長方形GHJKの頂点G、H、J、Kの相対座標を、算出する（図3中のステップS3）。これらの頂点のXY座標（他の形式の相対座標でもよい。）による相対座標は、 $G = (-a, c)$ 、 $H = (b, c)$ 、 $J = (b, -d)$ 、 $K = (-a, -d)$ として、算出することができる。これらの相対座標の原点は適宜変換してもよいことは、言うまでもない。

【0057】その後、統括制御・処理部26は、各距離

a～dに基づいて、次の数3により長方形GHJKの面積Pを算出する（図3のステップS4）。

【0058】

【数3】 $P = (a + b) \times (c + d)$

【0059】最後に、統括制御・処理部26は、ステップS1で測定された各距離a～d、ステップS2で算出された寸法L1、L2、ステップS3で算出された各頂点G、H、J、Kの相対座標、ステップS4で算出された面積Pを、表示部28に表示させ（図3のステップS5）、一連の動作を終了する。

【0060】以上説明した測定例では、寸法L1、L2が部屋の床（天井）の縦と横の寸法であり、各頂点G、H、J、Kの相対座標が部屋の平面図における各頂点の相対座標であり、面積Pが床面積（天井面積）である。本実施の形態によれば、これら値を、測距装置11の向きを前述したように1回だけ合わせるだけで測定することができ、したがって、その測定は極めて簡単である。そして、三脚等を必ずしも用いる必要がないことは、前述した通りである。

【0061】なお、例えば、照射光軸a～dが天井、互いに対向する1対の壁のうちの一方の壁、床、前記1対の壁のうちの他方の壁にそれぞれ垂直となるように、測距装置11の向きを設定すれば、残りの1対の壁の、寸法や各頂点の相対座標や面積を求めることができる。

【0062】前述した実施の形態では、照射光軸12a～12dはXY平面と平行な所定の基準平面内に含まれ、各照射光軸12a～12dの延長上に機械原点Oがあったが、本発明はこれに限定されるものではない。例えば、照射光軸12aはその向きを-X方向としたまま機械原点Oから任意の方向にずれていてもよいし、他の照射光軸12b～12dについても同様である。

【0063】また、例えば、照射光軸12cの向きは、図5に示すように、XY平面と平行な平面内において+Y方向に対して角度 θ_1 だけ傾いていてもよい。この場合、個別処理・駆動部20cから得られる距離は、図5中の距離 c' であるが、 $c' \cdot \cos \theta_1 = c$ の関係が成立するので、この関係を用いることにより、前述した実施の形態と同様に前述した各寸法等を求めることができる。なお、図5は図4に対応する説明図である。図5において、点C'は、照射光軸12cの向きを前述したように傾けた場合の、壁30cにおける照射光軸12cの延長上の点である。距離 c' は、機械原点Oから点C'までの距離である。

【0064】同様に、例えば、照射光軸12cの向きは、図6に示すように、YZ平面と平行な平面内において+Y方向に対して角度 θ_2 だけ傾いていてもよい。この場合、個別処理・駆動部20cから得られる距離は、図6中の距離 c'' であるが、 $c'' \cdot \cos \theta_2 = c$ の関係が成立するので、この関係を用いることにより、前述した実施の形態と同様に前述した各寸法等を求めることが

できる。なお、図6は図4に対応する説明図であるが、X軸方向から見たものである。図6において、点C''は、照射光軸12cの向きを前述したように傾けた場合の、壁30cにおける照射光軸12cの延長上の点である。距離 c'' は、機械原点Oから点C''までの距離である。

【0065】照射光軸12cの向きは、図5に示すように傾けてもよく図6に示すように傾けてもよいので、結局、+Y方向に対して任意の方向に傾けてもよいことがわかる。このことは、他の照射光軸12a、12b、12dについても同様である。結局、照射光軸12a～12dは、互いに異なる向きとなるように互いの相対的な位置関係が固定されていればよい。ただし、照射光軸12a～12dが四方の壁30a～30dにそれぞれ当たらなければ、前述したような寸法等を得ることができない。したがって、部屋の寸法は千差万別であることを考慮すると、照射光軸12a～12dは、所定の基準平面内又は該所定の基準平面と略平行な平面内に含まれ、照射光軸12a～12dを前記基準平面に写像したときに、前記基準平面内で略90°ずつの角度間隔を持つことが好ましい。

【0066】ところで、前述した実施の形態では、図3中のステップS2～S4に関連して説明したように、予め想定される形状として長方形を用い、図4中の四角形GHJKに関する寸法、頂点の相対座標及び面積を求めている。しかし、ステップS2～S4で想定する形状は、必ずしも長方形に限定されるものではなく、例えば、図7に示すような台形状を想定してもよい。この台形状を特定する情報（大きさを除く形状情報）としては、例えば、3つの角度を挙げることができる。この場合、幾何学的な関係から、点A、B、C、Dを各辺上を含む当該台形状を持つ台形G'H'JKの各辺の寸法、各頂点の相対座標、及び面積を、測距値a～dから算出することができることは、明らかである。このような台形状を有する部屋も多々ある。実際には、長方形を持つ部屋が圧倒的に多いことから、ステップS2～S4で想定すべき形状を長方形以外の形状にも測定者が設定できるようにし、統括制御・処理部26は、その設定された形状に応じて、ステップS2～S4の演算を行えばよい。このような形状の測定者の設定は、予め想定した種々の形状のうちから測定者が選択できるようにユーザインターフェースを構築したり、想定すべき形状を特定する情報を測定者が入力できるようにしたりすればよい。後者の場合、例えば、図7に示すような台形状であれば、測定者が予め何らかの手段で計測した部屋の3つの角度を入力できるようにしておけばよい。なお、図7は、図4に対応する説明図である。

【0067】以上は想定する形状を四角形状の場合について説明したが、想定する形状は、必ずしも四角形状に限定されるものではなく、他の任意の2次元形状であって

もよい。

【0068】以上の説明では、本実施の形態による測距装置11を室内計測装置として用いる場合を例に挙げて説明したが、本実施の形態による測距装置11の用途が室内計測に限定されないことは、言うまでもない。

【0069】〔第2の実施の形態〕

【0070】図8は、本発明の第2の実施の形態による測距装置40を示す概略構成図である。図8において、図1及び図2中の要素と同一又は対応する要素には同一符号を付し、その重複する説明は省略する。

【0071】本実施の形態による測距装置40が前記第1の実施の形態による測距装置11と異なる所は、主に、前記第1の実施の形態では、各照射光軸12a～12dに対応してそれぞれ個別送受信光学系13a～13d及び個別処理・駆動部20a～20dが設けられているのに対し、本実施の形態では、モータ等をアクチュエータとする機械式の光スイッチ41a～41dを採用することにより、送受信光学系及び処理・駆動部に関して各照射光軸12a～12dに対して共通化を図った点である。なお、本実施の形態においても、各照射光軸12a～12dの相対的な位置関係は、前記第1の実施の形態と同じである。

【0072】本実施の形態では、4つの照射光軸12a～12dを持つ送受信光学系は、それぞれ1つずつの発光素子14及び受光素子15と、前記光スイッチ41a～41dと、対物光学系16a～16dと、ハーフミラー17、42a～42dとから構成されている。発光素子14から発した照射光は、ハーフミラー17を透過した後、ハーフミラー42a～42dによって4つの光路に分岐され、それぞれ対物光学系16a～16dを経て各照射光軸12a～12dに沿って、照射されるようになっている。各照射光軸12a～12dの延長上に存在する各測定対象からの反射光は、照射光と同じ光路を経た後にハーフミラー17で反射され、受光素子15により受光されるようになっている。光スイッチ41a～41dは、前記分岐された4つの光路にそれぞれ配置され、対応する光路を開閉できるようになっている。

【0073】本実施の形態による測距装置40は、前述した送受信光学系の他、図2中の要素22a～25aとそれぞれ同じ動作を行う時間測定回路22、発光素子駆動回路23、増幅回路24及びA/D変換器25と、図2中の個別制御・処理部21a及び統括制御・処理部26に相当する機能も併せ持つ制御・処理部20と、光スイッチ41a～41dを駆動する光スイッチ駆動回路43と、を備えている。制御・処理部20は、例えば、CPU等を用いて構成される。なお、本実施の形態による測距装置40も、第1の実施の形態と同じく、操作部27及び表示部28を有している。

【0074】制御・処理部20は、操作部27からの測定の開始指令にตอบสนองして、まず、光スイッチ駆動回路4

3を制御して、光スイッチ41aのみを選択的に開き他の光スイッチ41b～41dを閉じた状態にする。この状態で、時間測定回路22に測距開始指令を与える。その結果、照射光軸12aのみから照射光が照射され、これに対応する反射光のみが受光素子15により受光され、時間測定回路22により照射光軸12aに沿った照射光の発光時と反射光の受光時との時間差が測定され、その時間差が制御・処理部20に与えられる。制御・処理部20は、この時間差に基づいて、測距装置40の機械原点Oから照射光軸12aの延長上に存在する測定対象までの距離aを、演算により求める。

【0075】次に、制御・処理部20は、光スイッチ41b、41c、41dの1つずつのみを順次選択的に開き、測距装置40の機械原点Oから照射光軸12b、12c、12dの延長上に存在する各測定対象までの距離b、c、dを、順次求める。

【0076】全ての距離a～dが得られると、制御・処理部20は、図3中のステップS2～S5の処理と同じ処理を行い、処理を終了する。

【0077】本実施の形態によれば、前記第1の実施の形態と同様の利点が得られる他、第1の実施の形態に比べて、部品点数が低減され、装置の小型化とコストダウンを図ることができる。なお、送受信光学系の少なくとも一部を搭載した導波路デバイスを用い、この導波路デバイス上に機械式光スイッチ41a～41dに代わる光スイッチを搭載すれば、更に装置の小型化とコストダウンを図ることができる。

【0078】〔第3の実施の形態〕

【0079】図9は、本発明の第3の実施の形態による測距装置50を室内計測装置として用いた場合の測定の様子を模式的に示す概略斜視図である。図9において、図1中の要素と同一又は対応する要素には同一符号を付し、その重複する説明は省略する。

【0080】本実施の形態による測距装置50が前記第1の実施の形態による測距装置11と異なる所は、図2の個別送受信光学系13c、13d及び個別処理・駆動部20c、20dが取り除かれ、これに伴い統括制御・処理部26の動作が変更されている点のみである。

【0081】本実施の形態では、統括制御・処理部26は、個別処理・駆動部20a、20bから各距離a、bが得られると、点A、B間の距離(=a+b)を算出し、点A、Bの相対座標を算出し、これらを表示部28に表示させ、処理を終了する。

【0082】本実施の形態によれば、1回の測定操作では対向する1対の壁30a、30b間の距離しか測定することができないが、従来の測距装置や従来のトータルステーションを用いて壁30a、30b間の距離を測定する場合に比べて、当該距離を簡単に測定することができる。

【0083】本実施の形態のように、測距装置50が2

本の照射光軸12a, 12bしか持たない場合であっても、測距装置50を図9に示す配置からZ軸回りに90°向きを変えた状態にして、もう1回同様の測定を行えば、図1中の壁30c, 30dまでの各距離c, dも得ることができ、ひいては、前記第1の実施の形態の場合と同様に、前記寸法L1, L2、各頂点G, H, J, Kの相対座標、面積Pも得ることができる。この場合、統括制御・処理部26は、操作部27からこのような1回目の測定である旨の指令や2回目の測定である旨の指令を受け、各指令に応答して、各距離a, bと各距離c, dとをそれぞれメモリに格納し、2回目の測定で各距離c, dが得られた後に、自動的に、各距離a~dに基づいて、前記寸法L1, L2、各頂点G, H, J, Kの相対座標、面積Pを算出して、表示部28に表示させてもよい。

【0084】なお、本実施の形態による測距装置50の用途も室内計測に限定されないことは、言うまでもない。

【0085】[第4の実施の形態]

【0086】図10は、本発明の第4の実施の形態による測距装置60を室内計測装置として用いた場合の測定の様子を模式的に示す概略斜視図である。図10において、図1中の要素と同一又は対応する要素には同一符号を付し、その重複する説明は省略する。

【0087】本実施の形態による測距装置60が前記第1の実施の形態による測距装置11と異なる所は、個別送受信光学系13b, 13d及び個別処理・駆動部20b, 20dが取り除かれ、これに伴い統括制御・処理部26の動作が変更されている点のみである。

【0088】本実施の形態では、統括制御・処理部26は、個別処理・駆動部20a, 20cから各距離a, cが得られると、点A, C間の距離($= (a^2 + c^2)^{1/2}$)を算出し、点A, Cの相対座標を算出し、これらを表示部28に表示させ、処理を終了する。

【0089】本実施の形態によれば、1回の測定操作では対向する1対の壁30aの点A, と壁30cの点Cとの間の距離しか測定することができないが、従来の測距装置や従来のトータルステーションを用いて点A, C間の距離を測定する場合に比べて、当該距離を簡単に測定することができる。

【0090】本実施の形態のように、測距装置60が2本の照射光軸12a, 12cしか持たない場合であっても、測距装置60を図10に示す配置からZ軸回りに180°向きを変えた状態にして、もう1回同様の測定を行えば、図1中の壁30b, 30dまでの各距離b, dも得ることができ、ひいては、前記第1の実施の形態の場合と同様に、前記寸法L1, L2、各頂点G, H, J, Kの相対座標、面積Pも得ることができる。この場合、統括制御・処理部26は、操作部27からこのような1回目の測定である旨の指令や2回目の測定である旨

の指令を受け、各指令に応答して、各距離a, cと各距離b, dとをそれぞれメモリに格納し、2回目の測定で各距離b, dが得られた後に、自動的に、各距離a~dに基づいて、前記寸法L1, L2、各頂点G, H, J, Kの相対座標、面積Pを算出して、表示部28に表示させてもよい。

【0091】なお、本実施の形態による測距装置60の用途も室内計測に限定されないことは、言うまでもない。

【0092】[第5の実施の形態]

【0093】図11は、本発明の第5の実施の形態による測距装置70を室内計測装置として用いた場合の測定の様子を模式的に示す概略斜視図である。図11において、図1中の要素と同一又は対応する要素には同一符号を付し、その重複する説明は省略する。また、図12は、本実施の形態による測距装置70による演算内容を説明するための説明図である。図13は、本実施の形態による測距装置70の動作の一例を示す概略フローチャートである。

【0094】本実施の形態による測距装置70の構成は、前記第1の実施の形態による測距装置11の構成と基本的に同様であるので、本実施の形態の説明に際して、図11乃至図13の他に、図2も参照する。

【0095】本実施の形態による測距装置70が前記第1の実施の形態による測距装置11と異なる所は、

(i) 図11に示すように、送受信光学系が4本の照射光軸12a~12dの他に2本の照射光軸12e, 12fを持つ点と、(ii) 送受信光学系が、個別送受信光学系13a~13dの他に、照射光軸12e, 12fにそれぞれ対応して個別送受信光学系13aと同一の構成を持つ2つの個別送受信光学系13e, 13f(図示せず)を有する点と、(iii) 照射光軸12e, 12fにそれぞれ対応して個別処理・駆動部20aと同一の構成を持つ2つの個別処理・駆動部20e, 20f(図示せず)が追加されている点と、(iv) 統括制御・処理部26の動作が変更されている点である。

【0096】本実施の形態では、照射光軸12e, 12fは、照射光軸12eの向きが+Z方向、照射光軸12fの向きが-Z方向となるように、照射光軸12a~12dに対する相対的な位置関係が固定されている。本実施の形態では、照射光軸12e, 12fは、測距装置70の機械原点Oを通る同一直線上にある。

【0097】次に、本実施の形態による測距装置70の動作の一例について、図13を参照して説明する。

【0098】例えば、本実施の形態による測距装置70を用いて室内計測を行う場合には、図11に示すように、測距装置70を室内に置き、照射光軸12a~12fが室内の各測定対象としての壁30a~30d、天井30e及び床30fに対してそれぞれほぼ垂直となるように、測距装置70の向きを決める。このとき、本実施

の形態では照射光軸12a~12fが筐体29の対応する側面、上面及び底面とそれぞれ直交しているの、これらの側面、上面及び底面を目安にして又はガイドにすることによって、測距装置70の向きを容易に設定することができる。例えば、筐体29の1つの側面を1つの壁に押し付けてもよい。理想的には照射光軸12a~12fが室内の壁30a~30d、天井30e及び床30fに対してそれぞれ厳密に垂直であることが好ましいが、その向きが多少ずれても測定精度にはあまり影響がない。ここでは、計測対象となる部屋は、直方体であるものとし、互いに対向する壁30a、30bが互いに平行であり、互いに対向する壁30c、30dが互いに平行であり、天井30eと床30fとが互いに平行であり、壁30a、30bと壁30c、30dとは天井30e及び床30fとはそれぞれ直交しているものとする。測距装置70は、例えば単に床などの上に置くだけでよく、必ずしも三脚等に搭載する必要はない。勿論、必要に応じて、測距装置70を三脚等に搭載してもよい。

【0099】図11に示すように、壁30a~30d、天井30e及び床30fにおける照射光軸12a~12fの延長上の点をそれぞれA、B、C、D、E、Fとする。これらの点と機械原点Oとの関係は、図12に示すようになっている。

【0100】測定者が、測距装置70をこのように配置した後、操作部27を操作して測定の開始指令を与えると、統括制御・処理部26は、この指令にตอบสนองして、各個別処理・駆動部20a~20fにそれぞれ測距開始指令を与える。各個別処理・駆動部20a~20f、これらの測距開始指令にตอบสนองして前述した動作を行い、機械原点Oから各壁30a~30d、天井30e及び床30fの各点A、B、C、D、E、Fまでの各距離a~fをそれぞれ統括制御・処理部26に供給する(図13中のステップS11)。なお、統括制御・処理部26は、個別処理・駆動部20a~20fを同時に作動させるように制御してもよいし、時分割的に順次に作動させるようにしてもよい。

【0101】次に、統括制御・処理部26は、個別処理・駆動部20a~20fから各距離a~fが得られると、各距離a~fに基づいて、図12中の直方体MNRSTUWの各辺の寸法L1、L2、L3を算出する(図13中のステップS12)。直方体MNRSTUWは、点A、B、C、D、E、Fを各面上に含み、かつ、予め想定された形状として直方体形状(3次元形状)を持つ、六面体である。各辺の寸法L1、L2、L3は、次の数4~数6により算出することができることは、明らかである。

【0102】

【数4】 $L1 = a + b$

【0103】

【数5】 $L2 = c + d$

【0104】

【数6】 $L3 = e + f$

【0105】次いで、統括制御・処理部26は、各距離a~fに基づいて、直方体MNRSTUWの頂点M、N、Q、R、S、T、U、Wの相対座標を、算出する

(図13中のステップS13)。これらの頂点のXYZ座標(他の形式の相対座標でもよい。)による相対座標は、 $M = (-a, c, e)$ 、 $N = (b, c, e)$ 、 $Q = (b, -d, e)$ 、 $R = (-a, -d, e)$ 、 $S = (-a, c, -f)$ 、 $T = (b, c, -f)$ 、 $U = (b, -d, -f)$ 、 $W = (-a, -d, -f)$ として、算出することができる。これらの相対座標の原点は適宜変換してもよいことは、言うまでもない。

【0106】その後、統括制御・処理部26は、各距離a~fに基づいて、数7~数9により、長方形MNRQ及び長方形STUWの面積P1、長方形RMSW及び長方形QNTUの面積P2、並びに、長方形MNTS及び長方形RQUWの面積P3を算出する(図13のステップS14)。

【0107】

【数7】 $P1 = (a + b) \times (c + d)$

【0108】

【数8】 $P2 = (c + d) \times (e + f)$

【0109】

【数9】 $P3 = (a + b) \times (e + f)$

【0110】次に、統括制御・処理部26は、各距離a~fに基づいて、次の数10により、直方体MNRSTUWの体積Vを算出する(図13のステップS15)。

【0111】

【数10】 $V = (a + b) \times (c + d) \times (e + f)$

【0112】最後に、統括制御・処理部26は、ステップS11で測定された各距離a~f、ステップS12で算出された寸法L1、L2、L3、ステップS13で算出された各頂点M、N、Q、R、S、T、U、Wの相対座標、ステップS14で算出された面積P1、P2、P3、ステップS15で算出された体積Vを、表示部28に表示させ(図13のステップS16)、一連の動作を終了する。

【0113】以上説明した測定例では、寸法L1、L2、L3が部屋の床(天井)の縦と横と天井高さの寸法であり、各頂点M、N、Q、R、S、T、U、Wの相対座標が部屋の各コーナーの相対座標であり、面積P1が床面積(天井面積)、面積P2、P3がそれぞれ壁面積であり、体積Vが部屋の容積である。本実施の形態によれば、これら値を、測距装置70の向きを前述したように1回だけ合わせるだけで測定することができ、したがって、その測定は極めて簡単である。そして、三脚等を必ずしも用いる必要がないことは、前述した通りである。

【0114】前述した実施の形態では、各照射光軸12a～12dの延長上に機械原点Oがあったが、本発明はこれに限定されるものではない。例えば、照射光軸12aはその向きを-X方向としたまま機械原点Oから任意の方向にずれていてもよいし、他の照射光軸12b～12fについても同様である。

【0115】また、前記第1の実施の形態の場合と同様に、照射光軸12cの向きは、+Y方向に対して任意の方向に傾けてもよい。このことは、他の照射光軸12a、12b、12d～12fについても同様である。ただし、照射光軸12a～12fが壁30a～30d、天井30e及び床30fにそれぞれ当たらなければ、前述したような寸法等を得ることができない。したがって、部屋の寸法は千差万別であることを考慮すると、照射光軸12a～12fは、所定の基準平面内又は該所定の基準平面と略平行な平面内に含まれ、かつ、照射光軸12a～12dを前記基準平面に写像したときに、前記基準平面内で略90°ずつの角度間隔を持ち、照射光軸12e、12fは、互いの向きが略180°をなすとともに前記基準平面に対してそれぞれ略90°をなすことが好ましい。

【0116】ところで、前述した実施の形態では、図3中のステップS12～S15に関連して説明したように、予め想定される形状として直方体形状を用い、図12中の直方体MNPQRSTUWに関する寸法、頂点の相対座標、面積及び体積を求めている。しかし、ステップS12～S15で想定する形状は、必ずしも直方体に限定されるものではなく、また六面体以外の他の任意の3次元形状であってもよい。この点は、前記第1の実施の形態においてステップS2～S4で想定する形状が長方形に限定されず任意の2次元形状であってもよいのと、同様である。

【0117】以上の説明では、本実施の形態による測距装置70を室内計測装置として用いる場合を例に挙げて説明したが、本実施の形態による測距装置70の用途が室内計測に限定されないことは、言うまでもない。

【0118】〔第6の実施の形態〕

【0119】図14は、本発明の第6の実施の形態による測距装置80の測定の様子を模式的に示す概略斜視図である。図14において、図9中の要素と同一又は対応する要素には同一符号を付し、その重複する説明は省略する。

【0120】本実施の形態による測距装置80が図9に示す第3の実施の形態による測距装置50と異なる所は、前記第3の実施の形態では、照射光軸12a、12bの互いの相対的な位置関係が固定されているのに対し、本実施の形態では、照射光軸12aを照射光軸12bに対して相対的にZ軸と平行な軸回りに回転させ得るように構成され、照射光軸12aの向きを照射光軸12bの向きに対して相対的に変更して設定できるようにな

っている点と、照射光軸12aの向きを検出するためのロータリーエンコーダ等の角度検出器（図示せず）を備えている点である。また、本実施の形態では、統括制御・処理部26は、照射光軸12aに沿った測定対象までの距離、及び、照射光軸12bに沿った測定対象までの距離のみならず、照射光軸12aの向きを示す角度にも基づいて、両測定対象間の距離を算出する。

【0121】照射光軸12aの向きを検出する角度検出器を設ける代わりに、照射光軸12aの向きを示す角度目盛を付しておき、測定者がその目盛を読み取って照射光軸12aの向きを示す角度を操作部27により入力し、統括制御・処理部26は入力された向きを用いるようにしてもよい。

【0122】本実施の形態によれば、前記第3の実施の形態と同様の利点が得られる他、照射光軸12aの向きを変更し得るので、任意の角度位置にある2点間の距離が測定できるなど、前記第3の実施の形態に比べて自由度の高い測定が可能となる。

【0123】なお、前記第3の実施の形態を変形して本実施の形態を得たのと同様の変形を、例えば、図1に示す第1の実施の形態や図11に示す第5の実施の形態に適用してもよい。

【0124】〔第7の実施の形態〕

【0125】図15は、本発明の第7の実施の形態によるトータルステーション90を模式的に示す概略斜視図である。図16は、図15中の100-100'線に沿った断面を模式的に示す概略断面図である。

【0126】本実施の形態によるトータルステーション90は、三脚91と、三脚91上に搭載された本体92とを備えている。本体92は、頭部93と、頭部93を水平軸回りに回転可能に支持する支持部94a、94bと、支持部94a、94bを鉛直軸回りに回転可能に支持するベース95と、有している。

【0127】本体92には、視準光学系と、図2中の個別送受信光学系13a、13b、個別処理・駆動部20a、20b、統括制御・処理部26、操作部27及び表示部28と、頭部93の支持部94a、94bに対する水平軸回りの回転角度（高度角度）を測定するエンコーダ等の高度角度用測角器（図示せず）と、支持部94a、94bのベースに対する鉛直軸回りの回転角度（水平角度）を測定するエンコーダ等の水平角度用測角器（図示せず）とが、搭載されている。

【0128】図16では、図2中の統括制御・処理部26、個別処理・駆動部20a、発光素子14a、受光素子15a及びハーフミラー17aの部分を、符号96で代表して示している。本実施の形態では、図2におけるハーフミラー17aと対物光学系16aとの間に、発光素子14aからの照射光を反射するとともに可視光を透過する特性を有するダイクロイックミラー97が介在され、ハーフミラー17aと対物光学系16aとの間の光

路が折り曲げられている。これにより、対物光学系16aが視準光学系用の対物光学系としての兼用され、照射光軸12aは視準光学系の光軸と一致している。視準光学系は、対物光学系16aと接眼レンズ系98とから構成され、望遠鏡を構成している。図16中の99は測定者の眼を示している。前述した要素96~97及び16aが頭部93に対して固定され、これにより、照射光軸12aは、前記水平軸回りの回転及び前記鉛直軸回りの回転によって任意の向きに向けることができるようになっている。

【0129】また、図16では、図2中の個別処理・駆動部20b、発光素子14b、受光素子15b及びハーフミラー17bの部分、を、符号101で代表して示している。これらの要素が、図16に示すように、ベース95付近に搭載され、照射光軸12bの向きは、ベース95の基準面が水平面となるように設置されたときに、鉛直方向の下向きになるように、ベース95に対する照射光軸12bの位置関係が固定されている。もっとも、照射光軸12bは下向きであれば、鉛直方向に対して傾斜していてもよい。

【0130】なお、図16では、操作部27及び表示部28の図示は省略している。

【0131】本実施の形態では、本来的な測定対象102の位置座標の測定に先立って、トータルステーション90の機械高を測定する旨の指令が操作部27から統括制御・処理部26に与えられると、統括制御・処理部26は、個別処理・駆動部20bに測距指令を与える。個別処理・駆動部20bは、前記第1の実施の形態の場合と同様の動作を行い、トータルステーション90の機械原点から地上までの鉛直方向の距離、すなわち、トータルステーション90の機械高を統括制御・処理部26に与える。この機械高は統括制御・処理部26の内部メモリに格納される。

【0132】次に、測定者が頭部93の向きを測定対象102を視準する向きに合わせ、位置座標の測定開始指令を操作部27から統括制御・処理部26に与えると、統括制御・処理部26は、個別処理・駆動部20aに測距指令を与える。個別処理・駆動部20aは、前記第1の実施の形態の場合と同様の動作を行い、測定対象102までの距離を統括制御・処理部26に与える。また、統括制御・処理部26は、前記高度角度用測角器及び水平角度用測角器から高度角度及び水平角度をそれぞれ取得する。そして、統括制御・処理部26は、前述のようにして取得された距離、高度角度及び水平角度に基づいて、測定対象102の座標を算出する。このとき、統括制御・処理部26は、先に取得された機械高も用いることにより、地上の基準点を基準とした測定対象102の座標を算出する。算出された測定対象102の座標は、表示部28に表示される。

【0133】本実施の形態によれば、前述したようにし

て機械高が得られるので、機械高の測定に手を要しない。

【0134】前述した第1乃至第7の実施の形態において、照射光の発光時と反射光の受光時との時間差は、クロックカウンタで測っても、光波の位相差によって測っても、他の方法によって測って良く、特に限定されない。

【0135】以上、本発明の各実施の形態について説明したが、本発明はこれらの実施の形態に限定されるものではない。例えば、照射光軸の本数は、前述した各実施の形態の例に限定されるものではない。

【0136】また、第1の実施の形態を变形して第2の実施の形態を得たのと同様の变形を、第3乃至第7の実施の形態に適用してもよい。

【0137】

【発明の効果】以上説明したように、本発明によれば、複数の測定対象までの距離を簡単に測定できる測距装置、または複数の測定対象間の位置関係等を簡単に求めることができる測距装置、または必ずしも三脚等を要しない測距装置、及びこれを用いた室内計測装置を提供することができる。

【0138】また、本発明によれば、機械高の測定に手を要しないトータルステーションを提供することができる。

【図面の簡単な説明】

【図1】本発明の第1の実施の形態による測距装置を室内計測装置として用いた場合の測定の様子を模式的に示す概略斜視図である。

【図2】本発明の第1の実施の形態による測距装置を示す概略構成図である。

【図3】本発明の第1の実施の形態による測距装置の動作の一例を示す概略フローチャートである。

【図4】本発明の第1の実施の形態による測距装置による演算内容を説明するための説明図である。

【図5】図4に対応する説明図である。

【図6】図4に対応する他の説明図である。

【図7】図4に対応する更に他の説明図である。

【図8】本発明の第2の実施の形態による測距装置を示す概略構成図である。

【図9】本発明の第3の実施の形態による測距装置を室内計測装置として用いた場合の測定の様子を模式的に示す概略斜視図である。

【図10】本発明の第4の実施の形態による測距装置を室内計測装置として用いた場合の測定の様子を模式的に示す概略斜視図である。

【図11】本発明の第5の実施の形態による測距装置を室内計測装置として用いた場合の測定の様子を模式的に示す概略斜視図である。

【図12】本発明の第5の実施の形態による測距装置による演算内容を説明するための説明図である。

【図13】本発明の第5の実施の形態による測距装置の動作の一例を示す概略フローチャートである。

【図14】本発明の第6の実施の形態による測距装置の測定の様子を模式的に示す概略斜視図である。

【図15】本発明の第7の実施の形態によるトータルステーションを模式的に示す概略斜視図である。

【図16】図15中の100-100'線に沿った断面を模式的に示す概略断面図である。

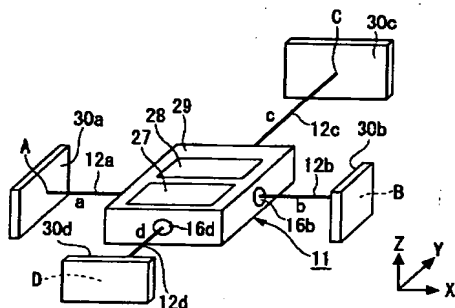
【図17】従来の測定装置による測定の様子を模式的に示す概略斜視図である。

【図18】従来のトータルステーションによる測定の様子を模式的に示す概略斜視図である。

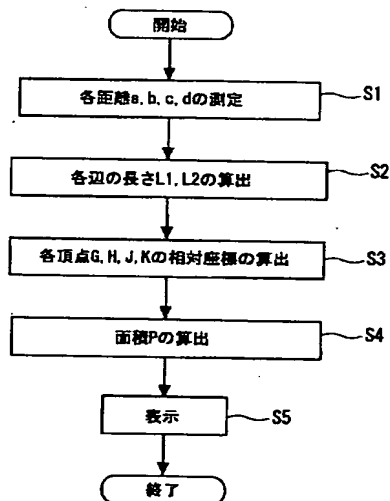
【符号の説明】

11, 40, 50, 60, 70, 80 測距装置
12a~12f 照射光軸
13a~13d 個別送受信光学系
14, 14a~14d 発光素子
15, 15a~15d 受光素子
16a~16d 対物光学系
20a~20d 個別処理・駆動部
26 統括制御・処理部
41a~41d 光スイッチ
90 トータルステーション
98 接眼レンズ系

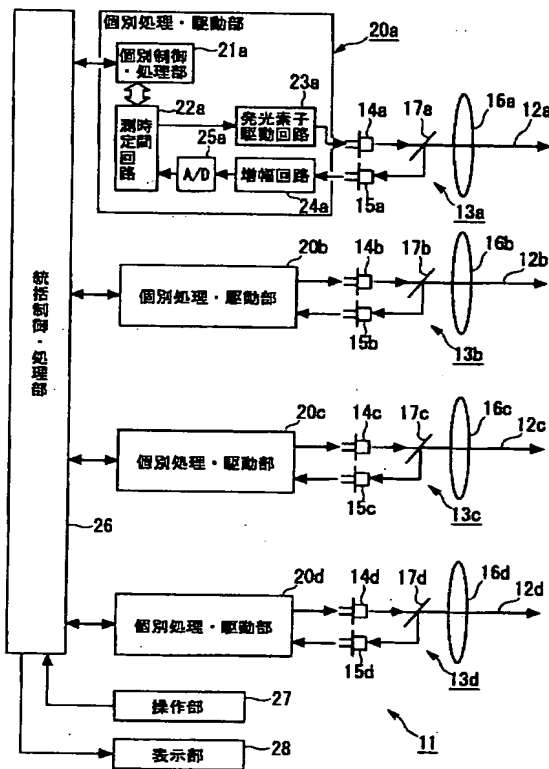
【図1】



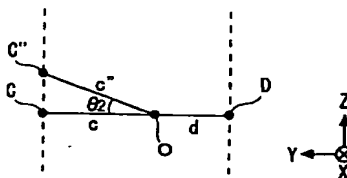
【図3】



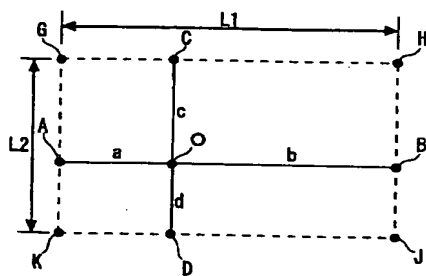
【図2】



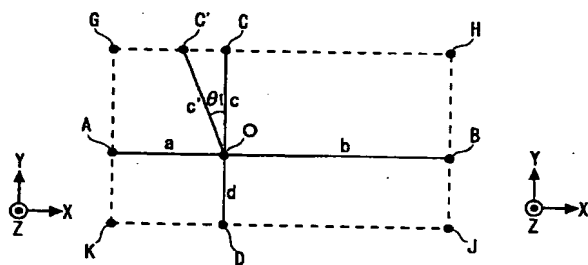
【図6】



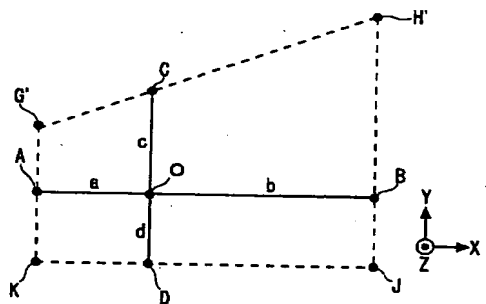
【図4】



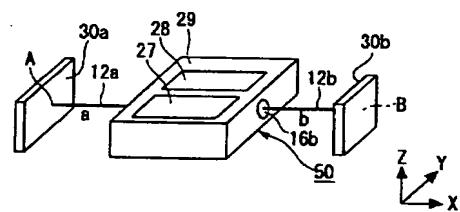
【図5】



【図7】

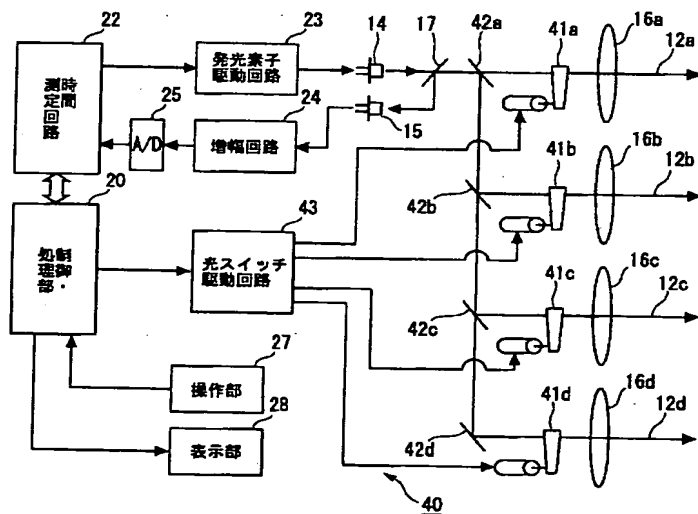


【図9】

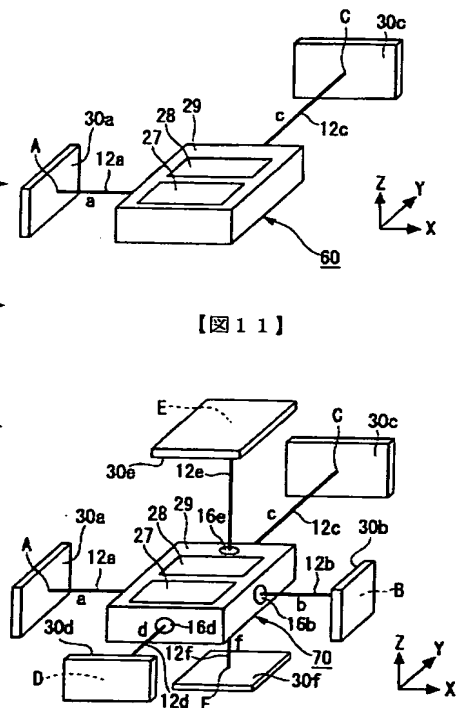


【図10】

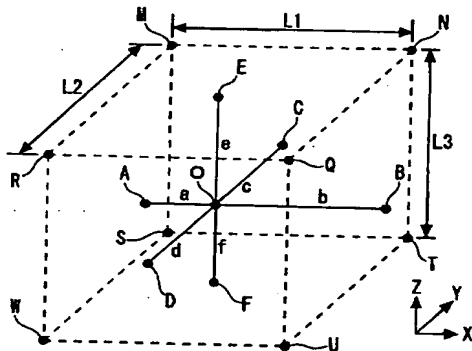
【図8】



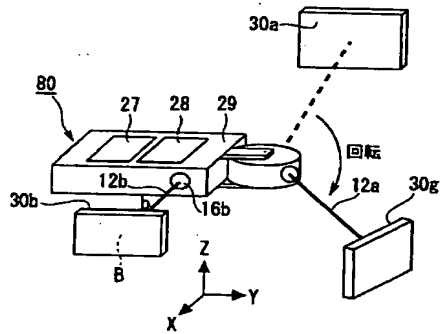
【図11】



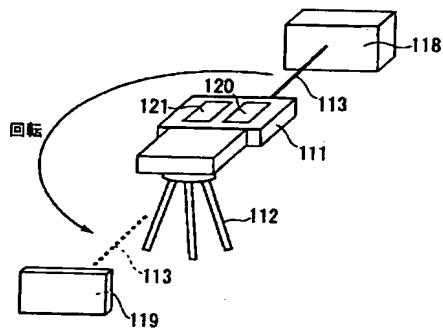
【図12】



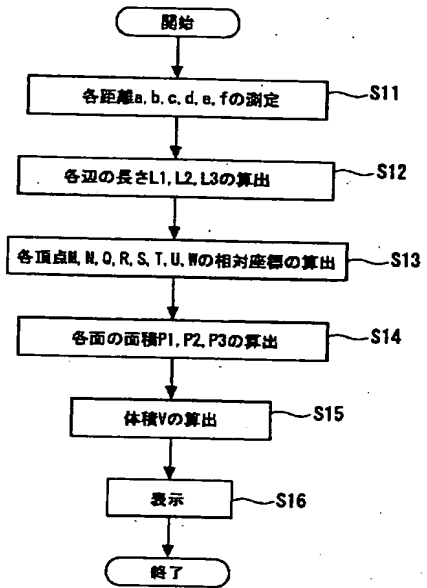
【図14】



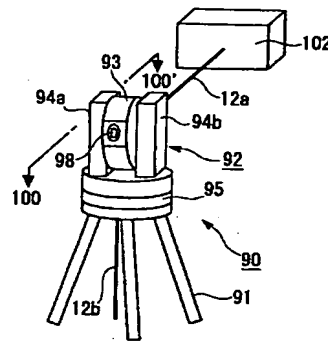
【図17】



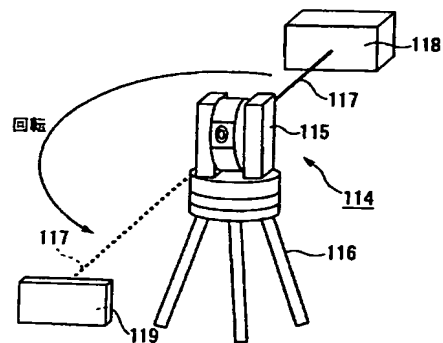
【図13】



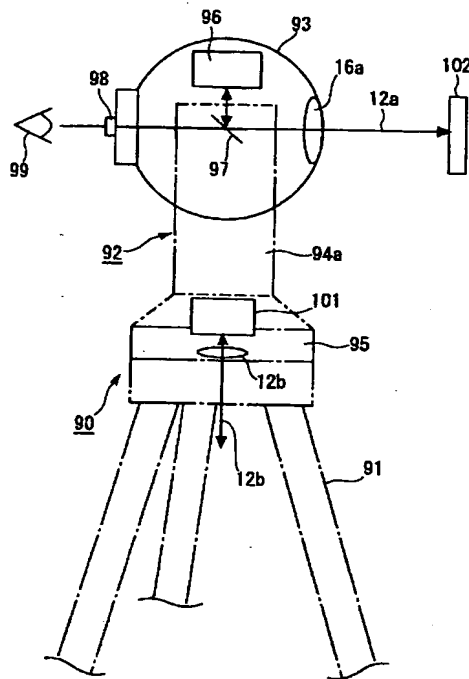
【図15】



【図18】



【図16】



フロントページの続き

Fターム(参考) 2F112 AD01 BA02 BA05 BA10 CA06
 DA02 DA09 DA30 DA32 FA03
 FA07 FA45 GA01
 5J084 AA04 AA05 AA10 AA11 AB20
 AC10 AD01 BA03 BA05 BA41
 BA47 BB24 BB31 CA03 CA49
 DA01 DA04 DA07 EA05 EA31
 EA34